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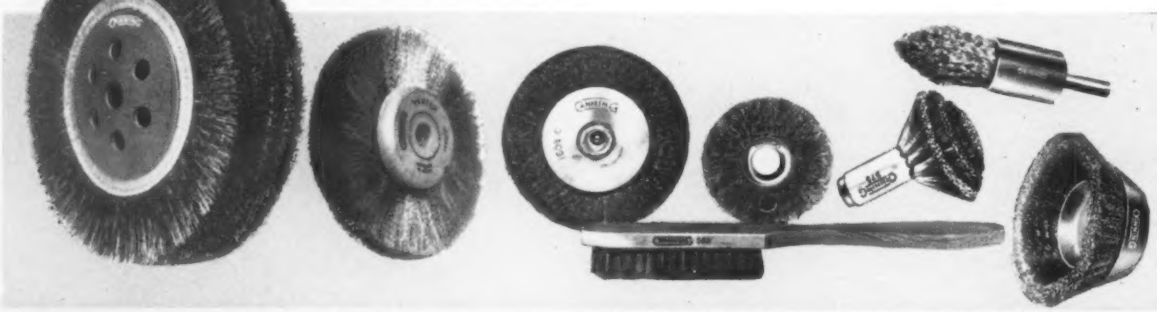

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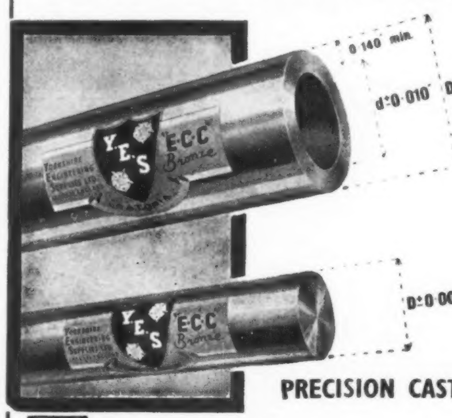

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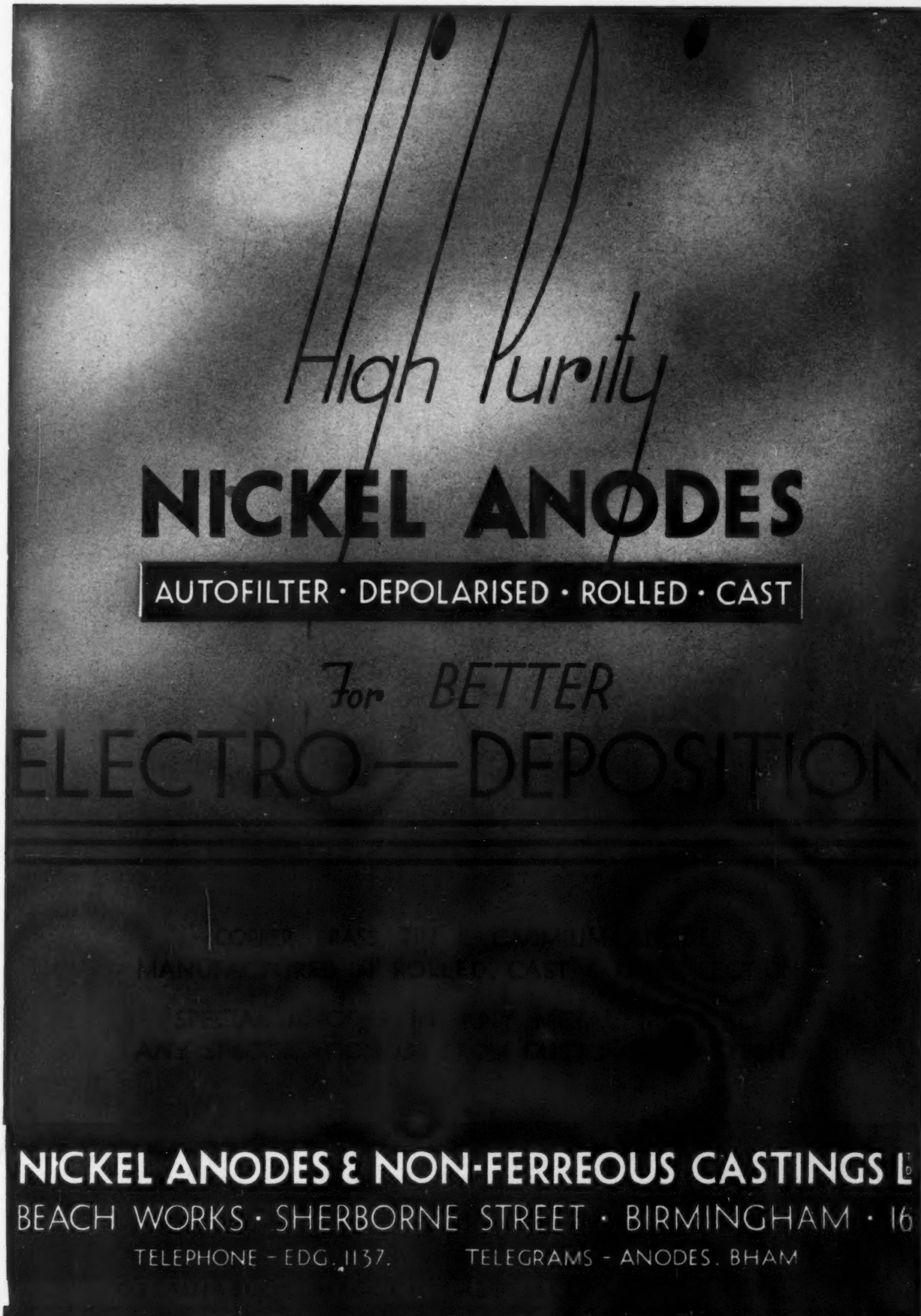
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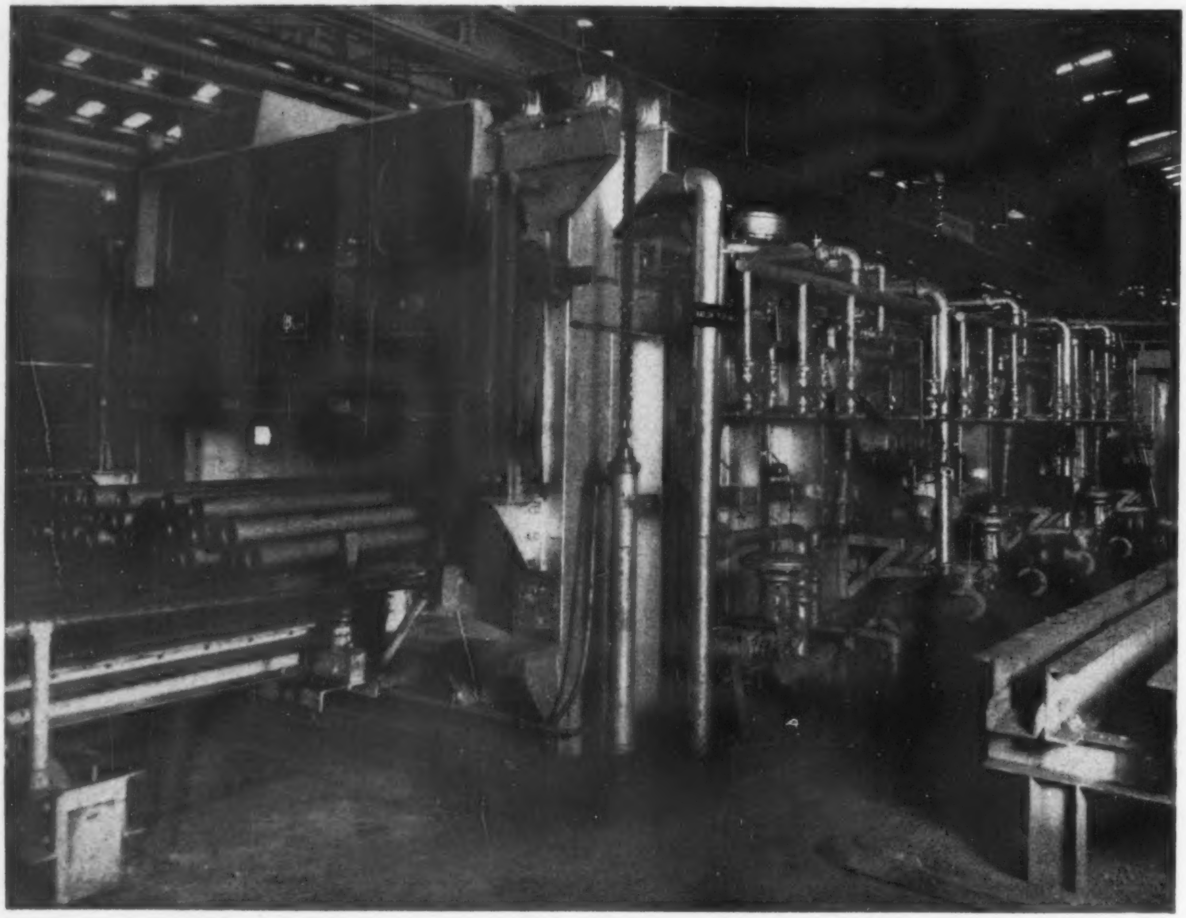

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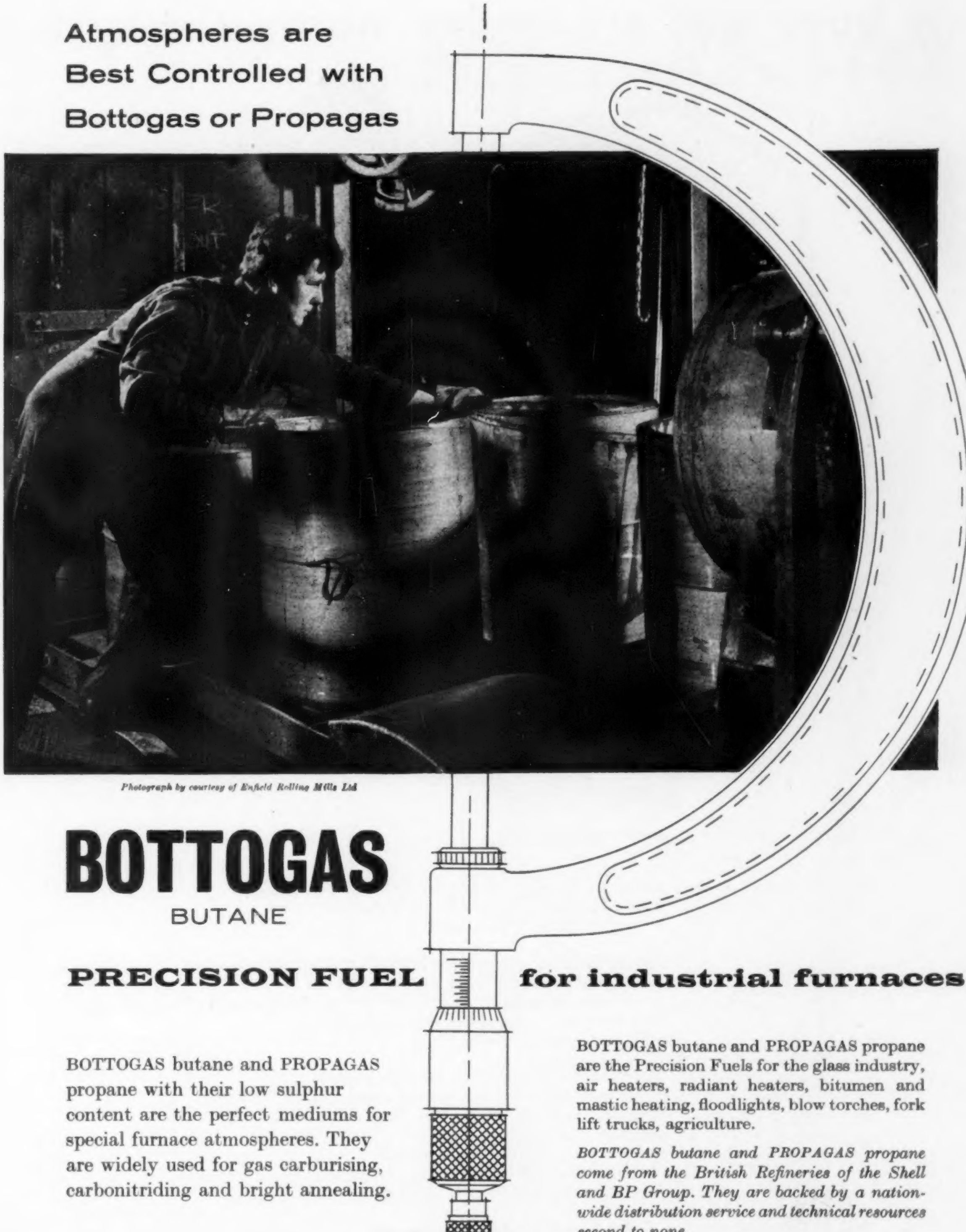

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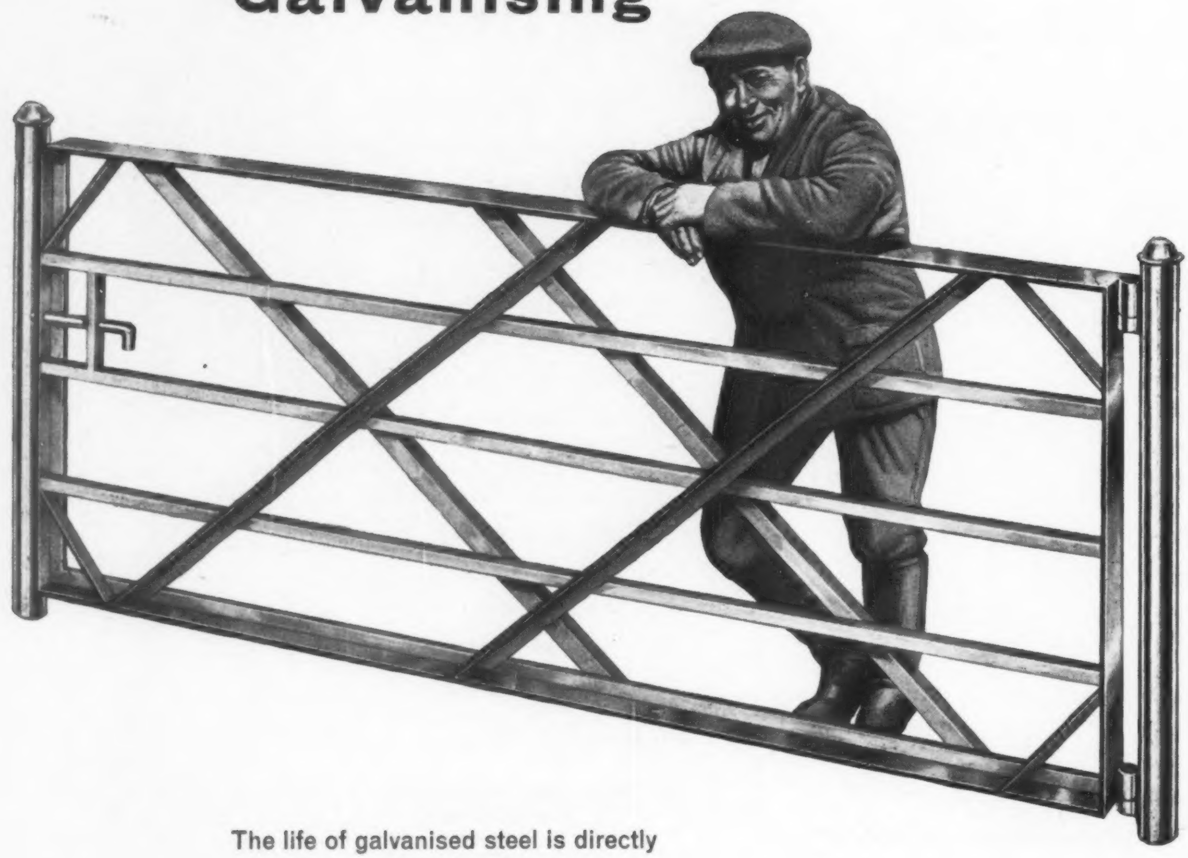

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Production Census

FIGURES, like the camera, can never lie. They can, however, be subject to distortion and, more particularly, to misinterpretation. For the last reason we approached the recently published report on the Census of Production for 1958 (Non-Ferrous Metals) with some caution. Since the conclusions we draw are rather startling and somewhat contrary to accepted thought, especially as regards productivity, it may well be that readers will have their own opinions.

The report itself relates to establishments engaged in refining copper, smelting and refining lead, zinc, aluminium, magnesium and other non-ferrous metals and the production in these metals and their alloys of ingots, bars, billets, sheets, strip, foil, circles, sections, rods, pipes, tubes, castings, extrusions, drop forgings, etc., but not of wire drawing or the production of finished goods. The manufacture of ferro-alloys, other than spiegeleisen and ferro-manganese is also included. Returns in full detail were required only from firms employing twenty-five or more persons, in contrast to previous censuses when detailed returns were supplied by those employing eleven or more. The total number of enterprises in the fields covered was 915, of which 334 employed twenty-five or more persons.

Highest net output per person employed was found in firms employing between 2,000 and 3,999 persons; the lowest, in fact some 25 per cent less, in those employing over 5,000. For these two categories the average total sales per firm were valued at £20,104,000 and £23,703,000 respectively. Net output is defined as the value added to materials by the process of production, including the gross margin on any merchanted or factored goods sold; it constitutes the fund from which wages, salaries, rents, rates and taxes, advertising and other selling expenses, and all other similar charges, have to be met, as well as depreciation and profits. On the face of it, therefore, it appears that there is nothing to be gained in productivity by increasing the number of employees beyond 4,000.

It is interesting also to compare the capital expenditure of firms employing between 2,000 and 3,999 people and those employing over 5,000. For the smaller firms the average capital expenditure is £240,000 and for the larger, £905,000. Again, it appears that expenditure on new plant does not automatically mean an increase in productivity. Interesting, too, are the figures for the number of operatives compared with the number of other employees. The highest ratio, 5:1, is to be found in those firms employing between 400-499 persons. The ratio is 4:1 for those employing between 2,000 and 3,999; surprisingly enough, this ratio is about the same for firms employing between 25-49. The ratio drops to 3:1 in firms employing 5,000 and over.

Non-Ferrous Metals in Missiles

By **P. N. Cornall,** D.C.Ae.E., A.F.R.Ae.S., A.M.I.Mech.E.

FOR the past quarter of a century, aluminium alloys have reigned almost unchallenged as the primary structural material for aircraft. Only now, when flight speeds are moving on to the higher supersonic ranges, do they show signs of giving way to stainless steels and other materials.

Even in the earliest days of powered flight, designers were well aware of the advantages of aluminium and its alloys. They were unable to exploit these advantages, however, until the pressure of demand in the first World War began to bring about the availability of the materials in economic quantities, but from the 'thirties onwards aluminium alloys have been the staple structural material of the aircraft manufacturer.

When, therefore, the aircraft industry began to turn its attention to the design and development of guided weapons, it was natural that there should be a disinclination to look beyond the tried and trusted aluminium alloys for the primary structures of the missiles themselves. Time has shown that decision to be well founded, although when the choice was made little was known of the effects that high-speed flight would have upon the materials.

The missile manufacturer and the manufacturer of military aircraft share a number of problems, not the least of which is the need to ensure that the supply of strategic structural materials can be maintained in time of war or crisis. The missile manufacturer, however, is dominated to a far greater extent by considerations of cost, of simplicity of design and construction, and of operational environment. These are not, of course, separate considerations; one interacts upon another and the greatest problem is, as in all fields of design, to arrive at the most satisfactory compromise between conflicting requirements.

At the heart of the missile manufacturer's problems is the fact that missiles are, by definition, expendable weapons. Unlike aircraft, a missile can be used once and once only. This inevitably imposes a strict cost ceiling, which in turn implies that methods of manufacture must be kept as simple as possible and that costly materials and processes are ruled out.

At the same time, however, a guided missile for, say, surface-to-air use is an intricate and complicated piece of machinery which must function with high accuracy and complete reliability under extremely severe environmental conditions. A surface-to-air weapon must be capable of standing by on its launcher on an exposed site for long periods, ready for action at the touch of a button. It must accelerate from launch to a speed well in excess of that of the speed of sound in a matter of seconds and it must be able to home on a high-speed target — which may be taking evasive action — at very high altitudes.

While simplicity and cost are largely functions of design, they can in some instances help to determine the choice of material, if only from the viewpoint of the production techniques which are economically permissible.

Operational Environment

The most important single criterion affecting the choice of material, however, is operational environment. Before any choice can be made, there must be a careful and detailed study of the operational requirements — operating height, speed, accelerations, range and so on—and the process may demand many months of calculation and experiment.

At the high supersonic speeds at which missiles operate, stiffness of a structure is as important as strength because of the need to avoid unsatisfactory flutter characteristics and the undesirable effects of distortions on the loading of the structure.

In addition, flight at high supersonic speeds brings the designer up against the phenomenon known as kinetic heating, where the stagnation temperature (in °C) of a structure is given approximately by the equation

$$T=\left(\frac{V}{100}\right)^2$$

where V is measured in m.p.h. Because of the thermal inertia of materials, the emissivity of heat from the structure

Fig. 1a—Variation of ultimate stress with temperature

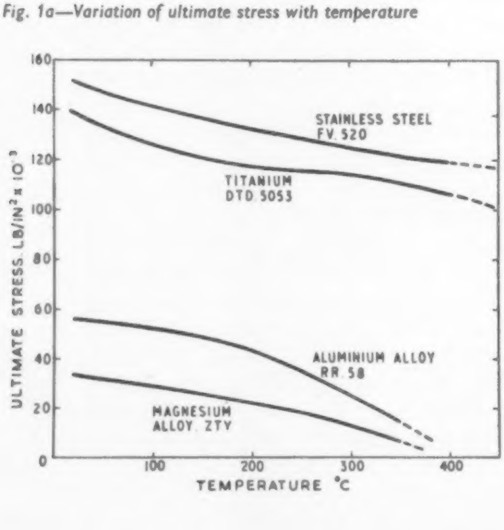
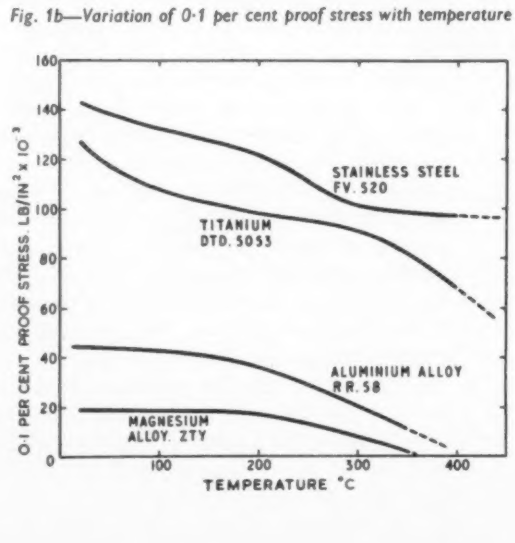


Fig. 1b—Variation of 0·1 per cent proof stress with temperature



Bristol/Ferranti Bloodhound missiles in readiness on their launchers

surface at high altitudes, and the relatively short time of flight at these speeds, however, it may be possible to "stretch" the performance of the structure of a missile beyond that which the material itself would stand if brought up to a saturated temperature.

Material Strengths

A comparison of the physical properties of typical materials available to the missile manufacturer is given in

TABLE I—SPECIFIED MINIMUM PHYSICAL PROPERTIES AT ROOM TEMPERATURE

Material	Ultimate Strength $lb/in^2 \times 10^3$	Proof Strength $lb/in^2 \times 10^3$	Elongation (per cent)	Density lb/in^3
Stainless steel FV520	152	143	12	0·283
Aluminium alloy RR58	56	45	6	0·099
Magnesium alloy ZTY	33·6	19·5	5	0·0633
Titanium DTD.5053	140	128	15	0·163

Fig. 2a—Variation of specific ultimate strength with temperature

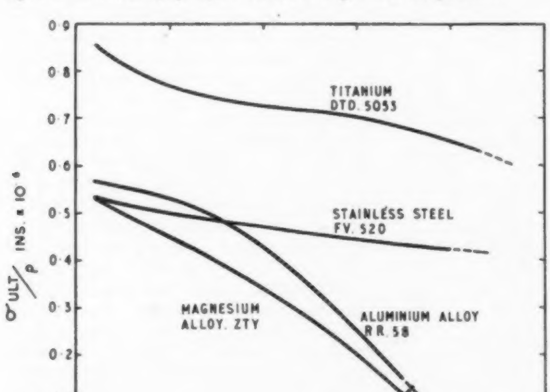
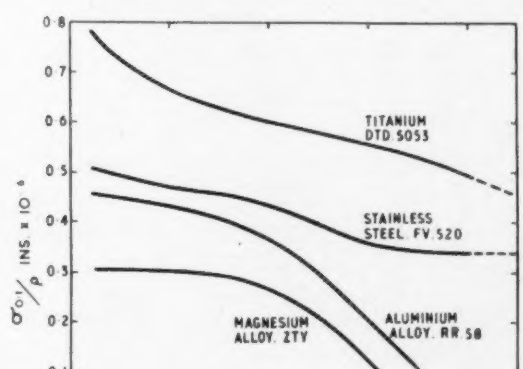
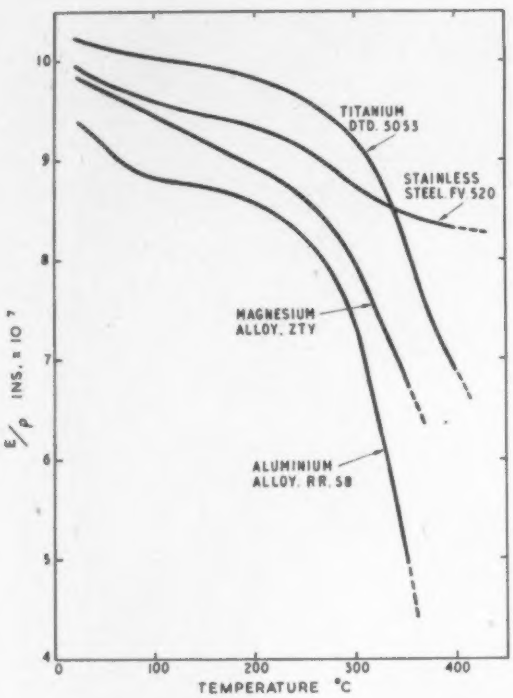
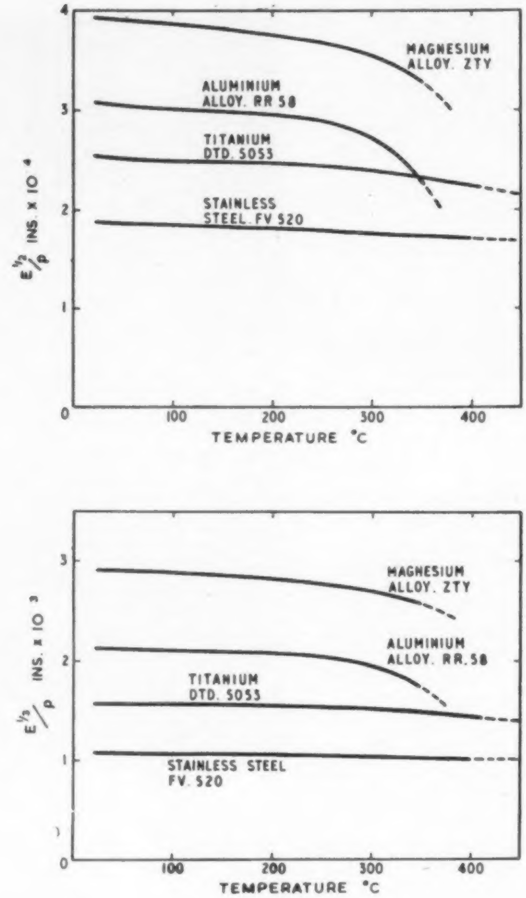


Fig. 2b—Variation of specific proof strength with temperature

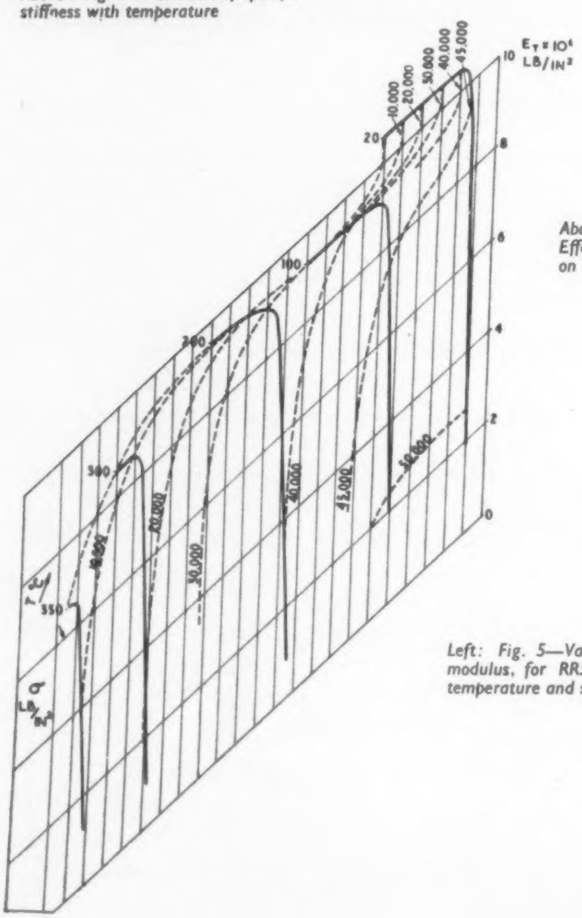




Above: Fig. 3—Variation of specific stiffness with temperature



Above right: Fig. 4—Effects of temperature on buckling criteria



Left: Fig. 5—Variation of tangent modulus, for RR58 material, with temperature and stress

Table I. Let us first consider the strength criteria.

The effect of soak temperatures on the ultimate and 0·1 per cent proof stresses is shown in Fig. 1. Since the missile designer, like designers in other engineering fields, must aim for as efficient a structure as possible, however, the form given in Fig. 2 represents a more useful tool. (It should, perhaps, be explained that proof and ultimate strengths are measured in lb/in^2 and ρ in lb/in^3, so that the resulting factors are measured in inches.)

From this figure, it can be seen that, for an efficient structure or component which is governed only by strength criteria (e.g., a tie rod or a beam in bending which has no local instability effects), titanium has a clear lead over the temperature range of from 0° to 400°C. Difficulties associated with machining and crack propagation, plus the high costs of preparing the basic materials in suitable form, have to date deterred designers from giving this material serious consideration, however.

Below 170°C., aluminium alloy establishes a claim for consideration, having a slight advantage over steel because of the latter's high density. The low annealing temperatures result

in a loss of strength in the higher temperature range which would lead to a low efficiency structure, but there are, in fact, other considerations which make aluminium alloy attractive even up to temperatures of the order of 250°C.

Magnesium, as can be seen from the curves, is more or less comparable with aluminium in the higher temperature regions, but, in fact, short-time creep effects, resulting in unacceptable aerodynamic alignments in a missile structure, rule out this material from serious consideration as a skin material.

Material Stiffness

Two distinct criteria govern consideration of the stiffness properties of the material. There is, first, the structural design criterion which is simply a function of Young's Modulus and, secondly, that based on the buckling phenomena.

So far as the first of these is concerned, Fig. 3 gives the variation of specific stiffness with temperature. Once again, titanium shows distinct advantages in the lower temperature regions, but the relative positions of magnesium and aluminium are now reversed, the penalties incurred by the latter far outweighing the limitations imposed by the high creep rates of magnesium.

While this curve provides a guide to comparative stiffness qualities, it is of limited practical value since stiffness can often be built into a missile structure by the use of concentrated booms which, because of their thermal inertia, reach a lower mean temperature at the end of the missile flight. In the higher temperature regions, a small reduction in temperature gives a large gain in stiffness to the booms.

Since the post-buckled stiffness is approximately one-third of the pre-buckled stiffness and because of the subsequent undesirable aerodynamic and aeroelastic effects, the limiting factor for the strength of a component is often that imposed by the buckling criteria.

For a cylinder in either compression or bending, $\psi\ \text{crit} = KE(t/R)$, where K varies from 0·12 to 0·4, depending on the R/t ratio (E being Young's Modulus and t and R the skin thickness and radius respectively). Substituting the weight of the cylinder in this equation reveals that the optimum weight for a given bending moment or end load varies approximately as $E^{1/2}/\rho$.

Similarly, the equation for a flat compression panel is $\psi\ \text{crit} = KE(t/b)^2$, where K is dependent on the a/b ratio and the end constraints. (Once again t is the skin thickness, while a and b are the panel dimensions.) The optimum weight in this case varies approximately as $E^{1/3}/\rho$.

Curves of these functions are shown in Fig. 4 and differ only in detail. In this respect, magnesium shows the most promising results because of the greater thickness of material and hence a larger lateral moment of inertia to resist buckling.

The word "approximately" has been used in the context above for a very good reason. This is that, to obtain the full benefits implied by these curves, it is necessary when using thin materials for the load-carrying skin to have stabilizing members in the form of stringers or ribs. This inevitably adds another penalty term in the weight optimization equations which is difficult to establish in general terms and which can be resolved only by detail analysis of the particular structure under consideration. In general, however, it can be said that ribs and stiffeners are to be avoided in missile design because they introduce complications from the point of view of manufacturing and interchangeability.

Frequently, the simple monocoque structures often used in missiles have fairly high skin stresses resulting from large bending moments imposed on the structure. Under these conditions, the fall in tangent modulus often brings about the premature buckling of the skins. Fig. 5, constructed with the aid of Ref. 2, shows the variation of E_T with stress and temperature for RR58 material.

Once again, generalized optimization of a structure weight cannot be established under these conditions but can be resolved only by detail analysis.

Effects of Kinetic Heating

In addition to the obvious effect of kinetic heating reducing the mechanical properties of material, there are two further criteria to be considered in choosing a material.

The first arises from differences in coefficients of expansion and is basically a problem shared with many other industries. Thermal stresses are set up in the structure and are proportional to Young's Modulus E, the temperature and the coefficient of expansion. The term "Thermal Stress Modulus"[1] is used for the quantity E (lb/in^2/°C.), values of which are shown in Table II.

For a compound structure such as a missile, a comparison of the order of thermal stress is provided by the differences in Thermal Stress Modulus. Unfortunately, in supersonic flow, the problem is further complicated by the heat transfer rates from the airstream as it changes across the profile of the missile, resulting in the nose or the leading edge being hotter than the rest of the structure. This, in itself, implies thermal stresses even in a structure made throughout of the same materials.

The second effect is a transient effect and is the product of the high accelerations necessary in missiles. The structure is cold at launch but, after an initial boost phase lasting only a few seconds, the missile attains full speed and is then subjected to the full effects of kinetic heating. While the inner structure is still cold, therefore, the outside skin surface becomes hot. The result is, of course, thermal stresses.

There are two distinct methods of tackling this problem, but neither provides a complete solution.

The first method is to choose a basic material which will conduct heat rapidly through the structure, so maintaining the internal structure temperature as close as possible to that of the skin. The quantity involved here is diffusivity, which is given by Thermal Conductivity divided by Specific Heat × Density. Table III gives comparative values for the four materials under consideration, and it can be seen that magnesium has a slight advantage in this respect over the aluminium alloys while both are something like ten times as good as titanium or stainless steels.

This approach cannot always be fully utilized, however, and a second line of attack is commonly employed. This compounds a structure in which the

TABLE II—THERMAL STRESS MODULI

Material	Young's Modulus lb/in^2 × 10^{-6}	Coefficient of Expansion × 10^{-6}	Thermal Stress Modulus lb/in^2/°C
Stainless steel FV520	28·2	16·5	465
Aluminium alloy RR58	10·8	22·5	243
Magnesium alloy ZTY	6·2	26·8	166·5
Titanium DTD.5053	16·7	9·1	152

TABLE III—COMPARATIVE THERMAL DIFFUSIVITY

Material	Thermal Conductivity Chu/ft.sec.°C	Specific Heat Chu/lb/°C	Density lb/ft^3	Thermal Diffusivity × 10^{-3}
Aluminium alloy RR58	0·0195–0·023	0·22	172·8	0·559
Magnesium alloy ZTY	0·0161	0·24	112·32	0·597
Titanium DTD.5053	0·00235	0·129	281·6	0·0648
Stainless steel FV520	0·00268	0·118	499·2	0·0456

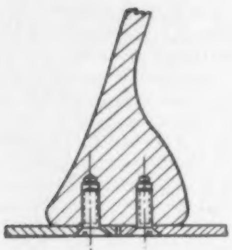


Fig. 6—Typical joint in a missile body

cooler inner structure is made of a material with a higher coefficient of expansion than the outer shell. The thermal stress will thus be reduced in the transient phase and there will be a residual thermal stress after soaking. By careful choice of materials, a fairly efficient structure can be achieved in this way, an example being the use of aluminium alloy skin with a magnesium inner structure such as is employed on the Bristol/Ferranti Bloodhound surface-to-air guided weapon.

A good deal of development effort has been devoted to the uses of external insulations on aluminium alloys to extend their effective operating range well above the 250°C. mark to obviate the severe weight penalty imposed when stainless steels — which might otherwise be considered suitable—are used in certain types of structure. Such techniques use materials with very low thermal diffusivity and ablating surfaces and can be shown to be very efficient, but they present mechanical problems of a formidable order.

Design Aspects

So far, only those technical aspects affecting choice of material have been dealt with, but there are also a number of important design criteria which must be watched to achieve the most efficient structure compatible with cost.

A typical joint in a missile body, which provides a simple, practical illustration of some of the problems to be considered and the kind of solution adopted to overcome them is shown in Fig. 6.

In this example, the skins are of aluminium alloy and the bulkhead is of magnesium, steel screws being used for attachment purposes. Reasonable efficiency of design is obtained by using the less dense material to form a ring stiffening member around the bulkhead and to provide sufficient material for the screw to be tapped direct into the flange. The skin is of sufficient thickness to allow the screw heads to be countersunk direct without incurring the penalty of doubling plates to ensure satisfactory bearing and shear characteristics. Again, the skin thickness is such that no ribs or stiffening members are needed to prevent buckling of the skin.

The disposition of the material is also favourable from the thermal stress aspects, for the aluminium has fairly good diffusivity properties while the magnesium, which has a larger effective area, is working at a lower stress and also has the lower Young's Modulus and the higher coefficient of expansion. The local heat sink effect, however, will cause a thermal gradient along the skins which will inevitably produce a tensile load in the screws during the transient phase of boost flight.

The importance of giving proper consideration to effects of temperature cannot be over-rated. A simple example is the use of a rod passing through a bush. If the rod is of aluminium or magnesium alloy and the bush is of steel, the temperature increase may be sufficient for the assembly to loosen and give unsatisfactory stiffness and vibration characteristics.

If, however, a steel rod passing through an aluminium or magnesium alloy bush is used, the effects of heating may then be to break the bolt. This condition is typical of a conventional bolted joint ring. Often, the effective area acting as a compound bar with the bolt has been queried, but experience has shown that the area in bearing under the head of the bolt can be considered adequate. Alternatively, the area of influence on the bolt can be taken as that of an annulus around the bolt and with an external diameter of twice that of the bolt. It is usual to take whichever is the greater of these two assumptions.

This is, of course, the simplest of examples but it does provide a pointer to the extent to which heating effects must influence detail design—and, as many readers will know, it is the simple factors which so often get overlooked, sometimes with serious and far-reaching consequences.

Corrosion Problems

Corrosion can be a problem with aluminium and magnesium alloys and it assumes particular importance in the case of surface-to-air or anti-aircraft missiles which are required to remain at readiness on their launchers for long periods, usually on open, unprotected sites and often in areas close to the sea. Jointing compounds are used extensively to prevent electrolytic action. Aluminium is generally anodized while magnesium was until recently stove-enamelled, although epoxy paints have now been proved to be satisfactory and are easier to repair or "make good".

Because of the large potential difference between steel and magnesium, precautions have to be taken to prevent steel bolts coming into contact with bare magnesium. Steel wire inserts are used and are sealed into place by an interface sealer which prevents damp from entering the crevices. This eliminates the majority of corrosion difficulties and has the added advantage of preventing thread wear.

In the design of magnesium components, it is also essential to avoid crevices and angles where condensation might gather and accelerate the corrosion process.

Material Handling Qualities

The materials so far discussed can all be obtained in reasonable quantities in both cast and wrought form, and the choice of which particular form shall be used and which design approach shall be adopted are frequently influenced by the handling properties.

The use of castings makes for simplicity of manufacture, employing simple machining operations. To avoid the necessity of providing additional attachments, it is essential in designing castings to provide brackets for the attachment or mounting of all associated structure. This may lead to a complicated pattern, but it has been found in practice that satisfactory results can be obtained with a free-pouring material. Again, to avoid unnecessary cracking of castings, a high elongation is also desirable in the material.

Magnesium has proved highly satisfactory for these applications, even for complicated forms combined with stainless steel inserts such as pipes, etc., and the introduction of the high strength magnesium alloys such as M.S.R., which have good high temperature properties, has further extended this philosophy of design.

From the strength aspect, however, castings must have an adequate reserve to allow for porosity and inclusions, a factor of 1½ being generally applied, and this naturally implies a weight penalty.

Wide use is also made of aluminium forgings and extrusions, which not only have the advantage of high strength but can also be supplied with complex profiles needing no further machining.

Rolled sheet material has a number of advantages for certain specific applications, one attraction being that it can be bent, folded, sheared, etc., with conventional tools with little spring-back. On the other hand, high strength aluminium alloys may call for intermediate solution treatments for which special equipment is required. Both aluminium and magnesium can be satisfactorily welded in the lower strength materials.

Titanium can be handled satisfactorily in sheet form, but the cutting forces induced by the use of negative rake cutters produce machining difficulties. The cost of the basic billets at present makes this material uneconomic for all but the most important missile components.

Other Materials

The materials dealt with are those which form the staple materials of guided missile production but there are others which are used either in small quantities for special purposes or which show promise of practical application

on some scale when development is farther advanced.

Both beryllium and molybdenum, for example, possess properties which could be of considerable importance in the missile field. To date, however, they have been debarred from extensive use because of their high cost and low availability and are found only in components where they appear to offer the one practical solution to a problem.

Beryllium, for instance, is particularly attractive from the aspects of stiffness and strengths. It has a very low density (approximately 114 lb/ft^3) but a Young's Modulus of around 44×10^6 lb/in^2 and an ultimate strength of around 100,000 lb/in^2. Its use might well be wider if it were available in sheet form.

So far as molybdenum is concerned, one of its main attractions to the missile engineer is the fact that it is erosion resistant up to 2,500°C. It is, therefore, in general use in the manufacture of rocket venturi nozzles.

Other "exotic" materials such as tungsten and germanium are employed but their use is confined mainly to electronic components. More "homely" metals such as copper and brasses are also used in the missile field in electric cables and for small, delicate instruments where magnetic protection is necessary.

Although they are outside the scope of this article, it should perhaps be mentioned that non-metallic substances are playing an increasing part in the missile structure. Extensive use is now made of resin-bonded mouldings for fairings and of resin and glass fibre laminates for radomes. Among recent advances are the use of ceramics in moulded or sprayed form for radomes and heat insulation shields, and the development of plastics such as P.T.F.E. for use as ablating thermal insulators.

There are also certain high strength materials which are already available but cannot be considered for missile structures because the production facilities of the mills are limited and because their strategic value makes their use in missiles undesirable.

Rapid strides are being taken in the technological development of both ferrous and non-ferrous materials. As a result, the advantages of aluminium and magnesium alloys will certainly be extended, but the indications are that, in the missile field, the time must come when these metals will be largely supplanted by the stainless steels.

Acknowledgment

The author wishes to thank the management of Bristol Aircraft Limited for permission to publish this article and to express his gratitude to those members of the staff of the company who co-operated in the collation of information.

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Vibratory Compacting

GREATER DENSITIES OBTAINED IN RUSSIAN POWDER METALLURGY INVESTIGATION

POWDER metallurgy methods now have wide application in industry, and have enabled many improvements to be made in the characteristics of known materials as well as the creation of new materials which could not be produced by other methods. The usual techniques involve compression at high pressures, and this raises certain difficulties. For example, considerable internal stresses occur, particularly concentrated at the contact points of molecular adhesion between the small particles, and these cause cracks to appear when the pressure is relieved. These internal stresses are particularly harmful in sintering processes where the lowered creep limit of a material at higher temperatures gives rise to plastic deformation in the contact regions and to additional destruction in many of the contacts which remain intact when the pressure is removed. Some improvement in this respect has been found by the use of surface-active lubricating surfaces, which assist in the relaxation of elastic stresses, but the cracking of pressings compressed at high pressures cannot be entirely prevented by this means.

Recent Russian work carried out by V. I. Likhtman, N. S. Gorbunov and I. G. Shatalova, and reported in *Doklady Akademii Nauk S.S.S.R.*, 1960, **134**, 5, 1150, has been concerned with the vibrational effects of compaction, developed from the techniques used in the manufacture of compact building materials from fine powders, in which dense packing is produced at comparatively low pressures. When compression is combined with vibratory stirring the pressing is packed far more densely, since all the initially formed contacts are broken by the vibration so that the particles mix freely and the smaller ones enter the pores between the coarser ones.

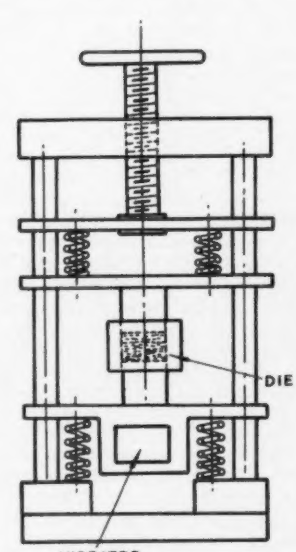
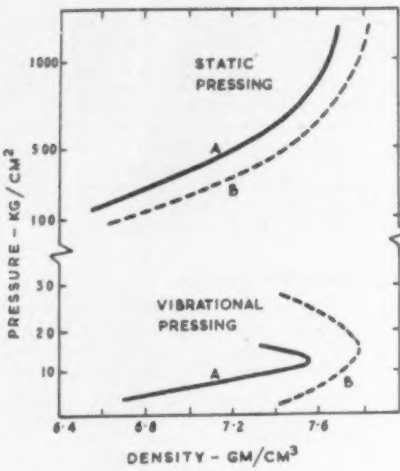


Fig. 1—Diagrammatic arrangement of vibratory compacting machine

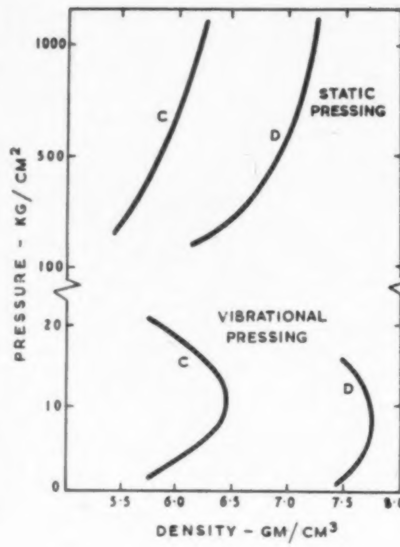
The Russian work was carried out with a mechanical vibrator having a frequency of 14,000 cycles/min. and an amplitude of 0·03 mm.; preliminary experiments had shown that in the compression of metallic powders, either alone or mixed with non-metallic particles, a denser packing is given with a high frequency and small amplitude. The vibrator was connected to the die by means of a flexible shaft, with the die mounted on springs. Pressure was exerted on the plunger by the screw through the upper springs, the magnitude of the pressure on the sample being determined by the deflection of the springs under the compression of the screw (Fig. 1).

The dispersion of the powder to be compacted and, in particular, its size distribution, has a great influence on the final density; as might be expected, coarser powders are compressed better than finer ones, i.e. other conditions being the same, pressings from relatively coarse particles (mean size 20 microns) have a higher density than those from finer ones (mean size 2 microns).



A—94 per cent WC, 6 per cent Co
B—60 per cent WC, 20 per cent Co

Left: Fig. 2—Test results with tungsten carbide and cobalt mixtures in static and vibratory compacting



C—95 per cent (TiW)C_2, 6 per cent Co
D—50 per cent (TiW)C_2, 44 per cent WC, 6 per cent Co

Right: Fig. 3—Static and vibratory test results with titanium-tungsten carbide and cobalt mixtures

Particularly good results have been obtained with polydisperse powders containing coarse as well as fine particles.

A comparison has also been made of the variation of density with compacting pressure under vibration, and work has also been reported on the same materials compacted under static or hydrostatic pressure alone. The results for powder mixtures of titanium and tungsten carbide with cobalt are given in Figs. 2 and 3. For a mixture of 6 per cent cobalt, 94 per cent tungsten carbide, and also for 20 per cent cobalt, 80 per cent tungsten carbide, the application of vibration allows the pressure of compacting to be lowered by about 100 times. Similarly, a complex titanium-tungsten carbide with 15 per cent titanium and 6 per cent cobalt gives a maximum density of 7·8 gm/cm³, when compacted with vibration under a pressure of 9 kg/cm², while with the static method this density is attained with a pressure of 1,500 kg/cm². Another mixture containing the complex carbide with 30 per cent titanium and 4 per cent cobalt by weight reached a maximum density of 6·4 gm/cm³ by the vibration method under a pressure of 12 kg/cm² and by static methods the pressure required was again 1,500 kg/cm².

The application of vibration when pressing different materials, either soft and plastic or very hard and brittle, allows the compacting pressure to be reduced by several orders of magnitude; it considerably improves the uniformity of the mixture and gives a uniform density throughout the whole pressing. At the same time, the formation of separation cracks caused by non-uniform density distribution and cracks associated with sintering processes are avoided. The technique discussed above is likely to be particularly useful in cases where the powder to be compressed is a mixture of components which differ considerably in specific weight, e.g. graphite and iron, or where the mixture contains a considerable amount of very hard and brittle powders (carbides of metals with a high melting point).

Treatment of Process Effluent

DESIGNED for the manufacture of semi-conductor devices, a plant has recently been constructed for the Texas Instrument Company, at Manton Lane, Bedford. Wherever possible, instrument control methods are employed and an example of one of these may be illustrated by the application of *p*H control during the treatment of process effluent.

During semi-conductor device processing, considerable quantities of effluent are produced. This effluent is made of hydrofluoric, acetic, and nitric acids of varying composition, together with water-miscible solvents and large quantities of process water. The *p*H value of the effluent can vary between 0·5 and 5·0 and have a biochemical oxygen demand of approximately 2,000. Quantities of up to 74,000 gallons a day with peak flows of 7,000 gal/hr. are continuously and automatically treated before disposal into the local authority's drains.

Treatment of the effluent comprises a single-stage chemical treatment followed by settling of solids and a final biological treatment. The effluent is first collected in two 3,000 gallon balancing tanks from which it is pumped under level control into a 1,500 gal. treatment tank, where lime slurry is added under *p*H control. Precipitation of solids takes place most effectively at *p*H values between 7·5 and 8·0, and Pye industrial *p*H measuring equipment, coupled to a Taylor pneumatic controller, adjust the rate of lime slurry addition to maintain these optimum conditions.

From the treatment tank, the neutralized effluent is passed through a large settling tank where the suspended solids, mainly in the form of insoluble calcium fluoride, are removed. The final biological treatment, where the water-miscible solvents are reduced to an acceptable level, precedes a final *p*H check. As the clarified liquor leaves the effluent plant, a continuous sample is taken and passed through a Pye flow type electrode assembly and a continuous recording of the final effluent *p*H value is taken before the effluent is passed into the drains.

The treated effluent conforms to the local authority's requirements with fluorides below 30 p.p.m., metals in suspension and solution 20 p.p.m., suspended solids 20 p.p.m., B.O.D. 300, and a *p*H value between 6·0 and 9·0.

The automatic *p*H control equipment employed on this plant was supplied and installed by W. G. Pye and Co. Ltd., Cambridge, to a rigid specification laid down by Texas chemical engineers.

OUT OF THE
MELTING POT

Everything Provided

USING ultrasonic vibrations to ensure satisfactory dip brazing involves no essentially new principle. The fact that a patent has been granted for what amounts to ultrasonic brazing is to be explained by the novelty and neatness of the particular embodiment of the principle. Everything has been thought of. There is first of all the brazing alloy which, preferably, should consist of 12 per cent copper, 5 per cent phosphorus, 5 per cent silver, 48 per cent zinc and 30 per cent aluminium. The alloy will successfully braze joints between aluminium and copper, aluminium and aluminium, Chromel and Alumel, copper and Constantan, and between stainless steel and stainless steels. Its melting point of 900°F. is sufficiently high to destroy any enamel coating on conductor wires, with the joining of which the invention is particularly concerned. Turning to the equipment that has been devised as part of the invention, the brazing alloy is melted in a small crucible formed in the vertically upturned end of a horizontal titanium rod which also acts as an ultrasonic energy coupling bar, its other end, at a distance of a full wavelength from the crucible, being acted upon by a magnetrostrictive transducer which produces vibrations of a frequency between 9,000 and 60,000 cycles per second. To heat the crucible formed in the end of the titanium rod, the latter is clamped between two contact jaws, each of which comprises a copper block, a stainless steel resistance tab and a graphite block which is in contact with the side of the crucible. By passing a current between the jaws, through the crucible, the graphite blocks and the crucible between them can be rapidly heated to 700°-950°F. to melt the brazing alloy. Further depression of a foot switch starts the high-frequency supply to the transducer and thus the transmission of ultrasonic vibrations to the brazing alloy. All that then remains to be done is to dip the joint, e.g. the ends of the wires that have been twisted together, into the brazing alloy for a few seconds.

Spherical Powder

RECENT references to metal powders having a spherical particle shape have been concerned more with the availability of such powders and their possible applications, e.g. in particular for filters, rather than with their manufacture. While the latter will, most probably, involve the atomization of molten metal, a process of this kind does not necessarily ensure that truly spherical particles are produced; particles having a tear drop or nodule shape may predominate due, among other factors, to the method of applying the gas blast. Production is more difficult still in the case of metals such as platinum, having high melting points. For these, a flame-spraying method has been developed in which a rod of the metal is fed through a nozzle into an annular high-temperature gas flame which is confined to the end portion of the rod, which it melts. The gas is not of sufficient velocity to be able effectively to blast molten metal from the end of the rod. For this purpose it is supplemented by a high-velocity gas, which is supplied through an annular nozzle surrounding the fuel gas nozzle and is directed towards the molten end of the rod from which it blasts small globules of metal. Beyond the end of the rod, the high-velocity gas diverges outwards from the spraying nozzle, at which stage the globules assume a spherical shape and are then carried by the gas into a cooling liquid. Approximately 90 per cent of the powder made in this way is in the form of spheres, of which about 80 per cent is usable for the manufacture of filter elements by sintering, the filter elements formed having a substantially uniform pore size throughout.

In One

IN determining the liquidus and solidus lines of an alloy equilibrium diagram by the familiar method of thermal analysis, a number of specimens of different composition are required, the preparation and examination of which usually take some considerable time. In theory, and now also in practice, it is possible to obtain the necessary information by observing the solidification of a melt of continuously varying composition. The continuous variation in composition can be achieved by continuously withdrawing the solidified fraction of the melt. In practice this is done by using an adaptation of Czochralski's method of preparing single crystals by progressive growth of the crystal as it is withdrawn from a melt. In the adaptation of the method to the determination of equilibrium diagrams, the starting alloy of suitable composition is melted in a graphite crucible. The temperature of the melt should be a little above the liquidus. A starter or seed rod is dipped into the melt through an opening in a graphite cover floating on the surface of the melt, the composition of the rod being that of the solid in equilibrium with the melt at the temperature of commencement of crystallization. After some preliminary melting of the rod, it is slowly withdrawn from the melt. In the process, the composition along the length of the rod which is formed will vary in a manner corresponding to the solidus line, while that of the remaining melt will vary along the liquidus. The composition of the bar can be determined by chemical analysis at points along its length, and the corresponding compositions of the melt can be calculated or determined by analysis of samples. These data can then be used to plot the liquidus and solidus of the equilibrium diagram of the particular alloy system. The other variable required for this purpose—the temperature—is recorded by a thermocouple fitted into the graphite cover with its tip as close as possible to the solidification front. As a practical precaution, stirring of the melt during the experiment may be advisable. The above method can also be adopted to the study of the more complex relations in ternary alloy systems.

Skimmer

MEN and Metals

Author of the article "Non-Ferrous Metals in Missiles", on page 162 of this issue, **Peter N. Cornall,** who is 31, is deputy chief stressman in the Guided Weapons Department of Bristol Aircraft Limited. Educated at Crewkerne Grammar School, Somerset, he joined The Bristol Aeroplane Company Limited as an apprentice in 1946. He joined the company's staff in the Guided Weapons drawing office

in the spring of 1951, becoming a lay-out draughtsman the following year. In October 1953, Mr. Cornall went to the College of Aeronautics at Cranfield for two years, where he specialized in aircraft design, with aerodynamics as his second subject. On his return to Bristol Aircraft, he worked in the Guided Weapons Project Office. In 1957, Mr. Cornall joined the Structures Group as a section leader, and on January 1, 1958, became deputy chief stressman, with responsibility for production and development missiles and, at that time, ground equipment. He is also concerned with many other technical aspects of missile design and manufacture. An Associate Fellow of the Royal Aeronautical Society and an Associate Member of the Institute of Mechanical Engineers, Mr. Cornall is the holder of a private pilot's licence, which he has held for three years.

Following the recent merger between the Delta Metal Company Limited and Enfield Rolled Metals Limited, the board of Delta-Enfield Rolled Metals Limited has been announced as follows: the chairman is the **Rt. Hon. The Earl of Verulam;** the vice-chairman is **Mr. C. C. Millar,** F.C.A., and **Mr. A. Lane** is managing director. The remainder of the board comprises **Mr. W. W. Dolton, Mr. S. Powell** and **Mr. W. J. Vaughton.** The secretary to the company is **Mr. W. W. Rigg,** A.C.A.

In view of the continued expansion of the business, Hedin Limited have appointed **Mr. Dennis Hobson** as sales manager of the furnace division. The sales of industrial ovens will continue to be handled under the managership of **Mr. Peter Keen.** These appointments will enable **Mr. James Royce** to devote more time to the research and development work of the company.

General manager of Simon-AMF, a joint company of American Machinery and Foundry Company of the United States and Henry Simon, **Mr. David G. Elias** has been made a director of the company. **Mr. Gordon O. Fraser** has been appointed as New York director, and **Mr. John M. Mellor** becomes a commercial director.

To act as an additional director, **Mr. J. P. M. Ferrier** has been co-opted to the board of Fairbairn Lawson Combe Barbour Ltd.

Recently elected a Fellow of the Institution of Metallurgists, **Mr. E. A. Shipley,** of British Ropes Limited, Doncaster, who also has an Honours B.Sc. degree of London University, joined the company two years ago as head of research of the wire division.

It is announced that the Pyrene Company Limited has appointed the following executives to be divisional directors: **Mr. H. A. Holden,** manager, metal finishing division; **Mr. Aubrey R. Lewis,** general works manager; **Mr. C. A. G. Naughten,** manager, bumper department; **Mr. A. Nicholson,** chief chemist; and **Mr. E. M. Woodman,** general sales manager.

Following upon the withdrawal of Crompton Parkinson Ltd. from the Atomic Power Constructions consortium, **Mr. J. V. Daniel,** the company's managing director, has resigned from the board of Atomic Power Constructions.

Birmingham branch manager of Cox and Danks Limited, a company in the Metal Industries Group, **Mr. Kenneth S. Bradshaw** has been appointed Cox and Danks' Midlands director based in Birmingham.

A new post of director of research for the direct supervision of its four research centres has been created by Associated Electrical Industries Ltd. **Mr. L. J. Davies,** previously director of research of AEI (Rugby), who also becomes a non-executive director of the Rugby company's board, has been appointed for the new post. **Dr. J. E. Stanworth** has succeeded Mr. Davies as director of research of AEI (Rugby). The other directors of research laboratories are: **Dr. T. E. Allibone,** Aldermaston; **Dr. J. M. Dodds,** Manchester; **Dr. M. E. Haine,** Harlow.

Recently appointed assistant home sales manager for Venesta Foils Limited, **Mr. Bryan K. Morley** joined the company's sales office five years ago, has been a sales representative for the past three years, and was the youngest member of the sales force.

General manager of Stewarts and Lloyds tube works at Coombs Wood, Halesowen, **Mr. C. B. McNair** is retiring owing to ill-health. He is to be succeeded by **Mr. W. H. Crawford,** at present general manager at Corby. **Mr. E. J. Whitfield,** the Coombs Wood works manager, is to be assistant general manager.

A director of British Insulated Callender's Construction Company and of Painter Bros., both members of the BICC group, **Mr. G. H. Walton** has retired after more than 47 years with the group and its predecessors.

High Density Sand Moulds

ENABLING high density green sand moulds to be produced with a wide range of green sand mixes, the latest Taccone Hydra Pneumatic high density moulding machine is now available in the United Kingdom from Baker Perkins Ltd., Westwood Works, Peterborough. A uniform hardness of up to 100 (Dietert) can be achieved using a combination of the Taccone slack diaphragm technique and hydraulic power.

The diaphragm is replaced by a multi-layer compensating pad which is expanded by normal line air pressure immediately prior to the upstroke of the cylinder. The air trapped behind the compensating pad (depending on the initial air pressure and the force supplied by the ram) can exceed 450 lb/in^2, giving a maximum hardness of 100 (Dietert). The combination of the expansion of the compensating pad and the upward stroke of the hydraulic cylinder maintains the sand in motion and this fluid action enables the sand to fill completely any pocket or crevice, ensuring a uniform density throughout the mould.

Care has been taken in the design and construction of the machine to ensure that all hydraulic units have been kept clear of the mould area to eliminate oil contamination of the moulding sand. Linked with suitable box handling plant, the machine promises a high potential output. Speeds up to 300 moulds/hr. can be achieved.

In order to overcome objections to using oil hydraulics for foundries, a fire-resistant fluid is used in the hydraulic circuits of the machine.

Terne Coated Strip

Pickling the rolls of sheet steel

TERNE coated sheet, now being produced in 50 ft. seamless rolls by Follansbee Steel Corporation of Follansbee, West Virginia, is again coming into wider use. The company has developed a method for continuously coating cold-rolled copper-bearing steel with terne metal—an alloy of approximately 80 per cent lead and 20 per cent tin—supplied by American Smelting and Refining Company.

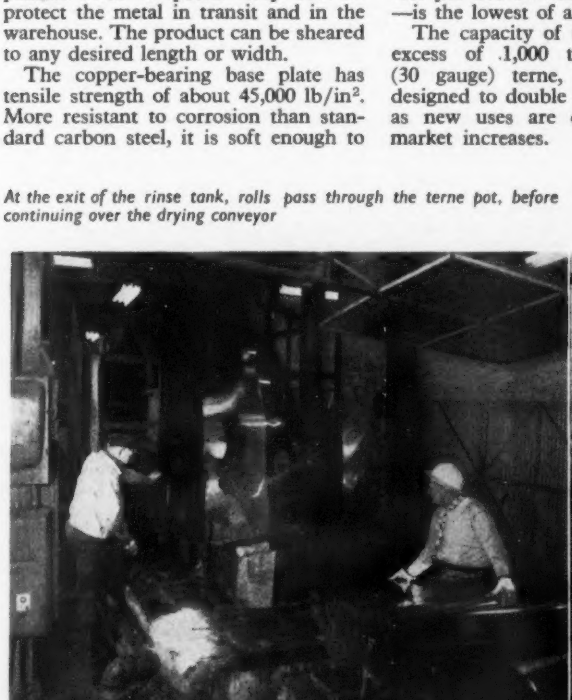
Special equipment is employed for producing terne strip, including a cutting line, pickler, rinse tank, terne pot, drying conveyor, inspection tables, leveller and recoiler. The terne pot, which holds the tinning flux and 40,000 lb. of molten terne metal, is operated at approximately 700°F. After the rolls pass inspection, they are painted with a special shop coat to protect the metal in transit and in the warehouse. The product can be sheared to any desired length or width.

The copper-bearing base plate has tensile strength of about 45,000 lb/in^2. More resistant to corrosion than standard carbon steel, it is soft enough to be crimped or formed into any type of seam without fracturing. Its expansion rate—approximately 0·8 in. in 100 linear feet per 100°F. change in temperature —is the lowest of any roofing material.

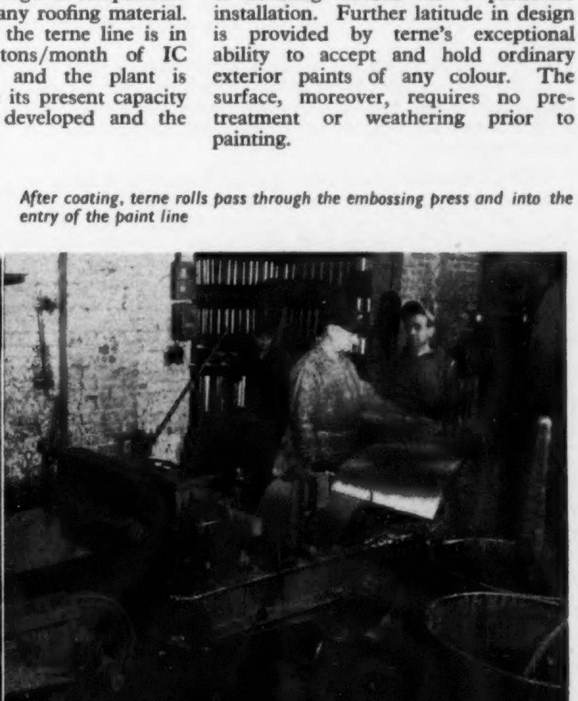
The capacity of the terne line is in excess of 1,000 tons/month of IC (30 gauge) terne, and the plant is designed to double its present capacity as new uses are developed and the market increases.

Various widths up to 28 in. are produced. These permit the architect or designer to apply terne in any form of seaming needed for a particular installation. Further latitude in design is provided by terne's exceptional ability to accept and hold ordinary exterior paints of any colour. The surface, moreover, requires no pretreatment or weathering prior to painting.

At the exit of the rinse tank, rolls pass through the terne pot, before continuing over the drying conveyor



After coating, terne rolls pass through the embossing press and into the entry of the paint line



Farnborough — 1961

STATIC EXHIBITS FEATURING NON-FERROUS METALS AT THE SOCIETY OF BRITISH AIRCRAFT CONSTRUCTORS DISPLAY

AT the static exhibition, S.B.A.C. Display, which will open on Monday next, September 4, at Farnborough, there will be a number of exhibitors showing products which will be of interest to the non-ferrous metals industry. There will, of course, be the usual flying display, but the static exhibition always attracts a large number of visitors. Among the exhibitors who have sent us details of their exhibits are the following:—

Alcan Industries Ltd. (Stand 189). This company gives major prominence to plate production on their stand. Since last year, their new 144 in. hot mill has come into operation at the company's Rogerstone works, and this is shown as the first unit in the sequence of plate production, which includes also heat-treatment, stretching, sawing and ultrasonic inspection.

Stress-relieved Noral alloy plate, made and tested on this equipment under the strictest control, is being used in the manufacture of such aircraft as the Vickers Vanguard and VC10 and Blackburn Buccaneer, all adopting the principle of integral construction. A section of a wing assembly built on this principle by Blackburn Aircraft Ltd. during the development of the Buccaneer wing will be shown. This shows not only wing skin planks but also a transverse rib member machined from plate.

Two very large exhibits will draw attention to Alcan's extensive facilities for the production of die- and hand-forgings. The most noteworthy is a propeller blade forging 9 ft. long, weighing some 3 cwt., which is the biggest ever produced by the company's Handsworth works. The blade is in Noral 17ST alloy and was forged on a 45,000 lb. hammer.

Also displayed will be an impressive hand-forged ring over 90 in. in outside diameter and weighing almost 8 cwt. Also included will be examples of the company's full range of aluminium semi-fabricated commodities used in aircraft manufacture.

British Insulated Callender's Cables Ltd. (Stand 201). A wide range of standard and specialized cables and accessories which emphasize the increasing application of these products in the fields of civil and military aircraft, and in guided missile development, the "Tersil" cables comprise nickel-plated annealed copper conductors insulated with silicone rubber, glass braided and terylene taped and braided and compounded with a special fluid-resistant lacquer.

Again, this year, BICC will display a selection of mineral insulated thermocouples with stainless steel sheaths. These have nickel-chromium and nickel-aluminium conductors and insulated hot junctions in the overall diameter sizes of 0·125 in. and 0·0625 in.

Various forms of controlled installation tools for quality control, which are supplied for hand, foot, pneumatic, hydraulic or electrical operation, will also be included in the BICC-Burndy Ltd. display.

Imperial Chemical Industries Limited (Stands 120, 121, 135, 136). Products from the I.C.I. are used in almost every civil and military aircraft produced in this country and the four stands occupied by the company at Farnborough will illustrate the scope of the company's activities in this field. The Metals Division features the ever-growing use of titanium for air frame and power plant components. In addition to a representative group of titanium fabrications, including a "Sea Vixen" wing rib using I.C.I. Titanium 317, there is a technical exhibit showing the method and result of various tests carried out by the aircraft industry on I.C.I. titanium alloys. Samples of wrought beryllium and niobium, materials of potential importance to aircraft designers, are among the "new" metals being shown.

Marston Excelsior Limited, a subsidiary company, features secondary surface and tubular heat exchangers in light alloy, titanium and stainless steel. Examples from a standard range of natural convection coolers for power transistors and special-purpose coolers for electronic equipment are also included, together with close tolerance sheet metal work components and flash butt-welded titanium engine rings.

The Paints Division offers to the aircraft industry a comprehensive range of metals pretreatment and painting systems to meet current specifications, and the Plastics Division provides examples of their varied applications which include components in "Perspex", "Fluon" (p.t.f.e.) and "Darvic" rigid p.v.c. sheet.

Precision Forgings Ltd. (Stand 214). Visitors will be particularly interested in the latest developments in blade forgings exhibited by this company, which is showing under its new name for the first time, having previously exhibited as the blade division of Garringtons Limited. The new factory established at Cwmbran, Mon., and equipped with new forging machinery designed and developed by Garrington technicians, is undertaking a wide variety of precision forged components in steel and non-ferrous metals produced by hot and cold forging methods, which include important consignments of turbine and compressor blades for noted makes of jet aircraft engines.

The exhibit presents typical examples of blade production together with their latest developments. Blades are being produced by forging methods to finished dimensions requiring no machining operations whatsoever on the aerofoil surface.

Reynolds Tube Company Ltd. (Stand 249). This company will be showing many of their specialized products, such as flash-welded rings and precision hollow extrusions for the aircraft industry. Flash-welded rings in heat-resisting metals such as "Nimonic" alloys, titanium alloys, etc., include rectangular dished rings, as well as the more usual circular ones, and rings designed for machining two jet-pipe flanges from one flash-welded ring.

Included among the precision hollow extrusions are air starter cartridge cases, "bodies" for steel pressure vessels, hydraulic cylinders, etc., and exhibits illustrating the wide potential for internal and external integral end forms, and demonstrating the close tolerances achieved. Other exhibits will be indicative of the company's skill in tubular manipulation and assembly.

Westinghouse Brake and Signal Co. Ltd. (Stand 238). Demonstrations of two applications of "Trinistor" silicon controlled rectifiers will be given on this stand. One is a power inverter producing an output at 400 c/s with a truly sinusoidal waveform; the other, a compact A.C. power regulator, rated at 13 kVA, incorporating a fan for forced-air cooling. Other exhibits will include a full range of silicon diodes rated from 750 mA to 175 amp. with peak reverse voltages of 100 to 1,200 or 1,800 V.

The new Westinghouse H series crystal aligned rectifiers will also be shown. This range utilizes aluminium-based selenium elements manufactured by an automatic and closely controlled vacuum deposition process. Other selenium type rectifiers to be displayed will include light-weight high temperature units up to DEF 5243, capable of operating in ambient temperatures of up to 85°C., and miniature and tubular rectifiers in various types of assemblies.

Industrial News

Home and Overseas

Business Expansion

As a result of the continuing expansion of their business, **Hedin Limited** have taken over additional office and works accommodation at Fowler Road, Hainault, Essex. The manufacture of their industrial heating elements and resistances will continue to be carried out at the South Woodford works, while furnaces and ovens will now be made at Hainault.

The increased works capacity will enable the company to undertake the fabrication of much larger and more highly mechanized heating equipment, and eventually to extend their activities to cover fuel-fired as well as electrically heated equipment.

Gear Units Manufacture

News from **David Brown Industries Limited** is that, following on the recent announcement that the company had leased a factory on the Pallion Trading Estate at Sunderland, for the purpose of manufacturing gear units, it is now announced that the first machines will be installed in the Sunderland premises during the early days of this month.

Approximately ten David Brown employees will be transferred from the Huddersfield works as a nucleus staff and it is hoped, by local recruitment, to have about 200 employees by the end of the year.

Advice on Bulk Storage

For advising and assisting all their customers who wish to take advantage of the company's bulk delivery service, **F. W. Berk and Co. Ltd.** have appointed Mr. E. G. Jewell, of the company's London Colney works, as bulk storage advisory engineer.

Bulk storage of liquids in tanks not only ensures continuity of supply, but also eliminates the cost of handling returnable containers. In many cases, tanks can be constructed in less space than is required by stacked containers, and, particularly where underground tanks are permissible, valuable space can be made available for other purposes. Delivery by tanker is speedier and often safer, with less danger of loss by contamination and spillage.

International Tin Report

The fourth report of the **International Tin Council** covers 1959-60, a period primarily of export control. Control over the exports from the main tin-producing countries was in operation for the whole year but on a modified scale (for example, 25,000 tons in the quarter July-September, 1959, but almost back to normal at 37,500 tons in April-June, 1960). The buffer stock was in general a seller—if not on a large scale—during the year, either on its own account or on account of the United Kingdom stockpile. Tin prices in London, New York and Singapore were remarkably steady. Supplies from the U.S.S.R. and China were beginning to fall. At June 30, 1960, the buffer stock held over 10,000 tons of metal and over £11,000,000 in cash.

The report contains an interesting and detailed summary of the provisions of the Second International Tin Agreement, which was drawn up in New York in 1960 and which entered into force on July 1, 1961. It is available from the International Tin Council, 28 Haymarket, London, S.W.1, at 7s. 6d. post free.

Solder for United States

An order worth $180,000 (over £64,000) for a quarter-million lb. of solder was received by **Multi Core Solders,** of Hemel Hempstead last week, from British Industries Corporation of Port Washington, New York, an associate of Avnet Electronics of the U.S.

Delivery of the solder is to start immediately, and the company's plant is expected to work overtime to complete the order by early next year.

Permanent Magnet Alloy

A new data sheet describing their cobalt-platinum permanent magnet alloy Platinax II has been issued by Johnson, Matthey and Co. Limited, 73-83 Hatton Garden, London, E.C.1.

This material is the latest development in magnetic alloys of the cobalt-platinum system, and with a BH_{max} of $9{\cdot}2 \times 10^6$ gaussoersteds is one of the most powerful permanent magnet materials known. Before its final heat-treatment it can be rolled, drawn, or machined without difficulty.

As well as general data previously included, the new publication gives information on the heat-treatment process, on reversible permeability, and on behaviour at elevated temperatures.

New London Stock Rooms

Extending their stockholding service to their London branch, Crofts (Engineers) Limited, power transmission engineers, of Bradford, have a showroom displaying the wide range of stock products and a representative selection of the company's specialized products at 36-42 Tanner Street, Bermondsey, London, S.E.1.

The technical and estimating service, a feature of all branches of Crofts (Engineers) Limited for so many years, is being further augmented at these new offices under the management of the London director, Mr. H. W. Cameron.

Production Engineering Research

In 1960, a special study was made by the **Production Engineering Research Association** of the need for a World Register of Production Engineering Research to assist research workers and production engineers to keep fully informed about investigations carried out in research organizations, industrial firms, universities and colleges throughout the world.

The World Register will cover all production research carried out in the years 1959-62, and will summarize plans for research for the following three years. The main subjects to be covered are: automation, machine tools, materials handling, finishing processes, metal forming, assembly, inspection and measurement, metal cutting, and machinability and formability of materials.

The Register will give as much information as can be obtained about establishments carrying out programmes of research relevant to production engineering, including details of the researches undertaken, the staff, workshops, laboratories, special facilities and equipment. The survey is also expected to provide information on publications, educational services, etc. This information will be sought by means of a questionnaire which is now being sent to research establishments, industrial organizations, universities, colleges and trade associations in many parts of the world.

Organizations carrying out any form of production engineering research are invited to write to The Information Manager, PERA, Melton Mowbray, Leics., for a copy of the questionnaire. This will help considerably in making the Register a complete international record of production engineering research.

Alumina Project Suspended

Work on the Boke alumina and bauxite project, in the Republic of Guinea, sponsored by Aluminium Limited, is being suspended due to inability so far to solve the financial problem involved under present circumstances.

Bauxites du Midi—Aluminium Limited's French subsidiary—commenced work on the Boke project in 1957, looking towards the development of a combined alumina and bauxite export project based upon bauxite reserves in the Boke region. Considering the size of the development, Aluminium Limited in 1960 enlisted the support of several other major aluminium producers in North America and Europe to join in providing interim financing while determining whether appropriate long term financing could be obtained.

The project calls for total expenditure of approximately 175 million dollars.

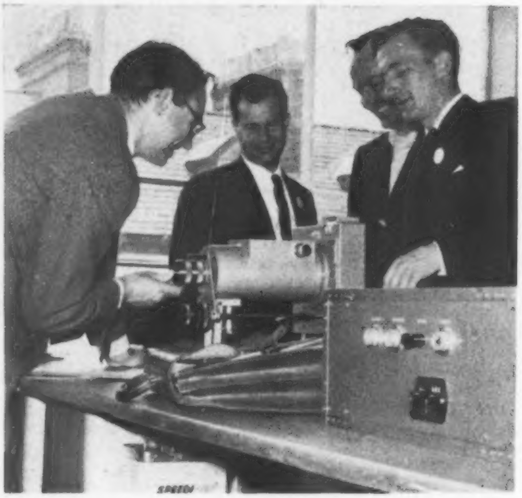
Drainage Pipe in Aluminium

Spiral corrugated drainage pipe, now available for the first time in aluminium in the United States, is being marketed there through a network of independent culvert manufacturers by Kaiser Aluminum and Chemical Sales Inc. The new product, called "Corlix", is fabricated from the same aluminium alloy as Kaiser Aluminum's regular corrugated culvert sheet, and is designed for use as underdrain and downdrain pipe in highway and general construction work. Its light weight makes installation easy and economical, and it can be readily cut with conventional hand or power tools at the job site.

The spiral corrugated pipe is available, perforated or unperforated, in 18-, 16- and 14-gauge wall thicknesses. Although 6 in., 8 in., 10 in. and 12 in. diameters are standard, larger sizes and heavier gauges are available upon request.

Malayan Tin Production

Tin production in Malaya in July increased over the June tonnages, according to Malayan mining statistics. Production reached 114,826 piculs of tin-concentrates in July, containing 5,170 tons of tin metal based on the true assay of 75·64 per cent. This compared with a June output of 106,723 piculs, containing 4,807



Delegates from the Summer School on X-Ray Microanalysis examine a Microscan spectrometer during a visit to the laboratories and works of the Cambridge Instrument Company. (Centre) Mr. Elion of Elion Instruments Inc., U.S.A. (2nd from right) Prof. R. E. Ogilvie of Massachusetts Institute of Technology. (Extreme right) Dr. D. A. Melford of Tube Investments Research Laboratories

tons of tin metal based on the true assay of 75·67 per cent.

At the end of July there were 71 dredges, 537 gravel pump mines and 50 other tin mines in operation, making a total of 658 active tin mines. This compared with end-June figures of 70 dredges, 515 gravel pumps and 53 others, making a total of 638.

Increased output from the Chinese-owned gravel pump mines is the main reason for the rise in total tin production in July, 22 more of these mines being operated.

The rising price of the metal has induced companies to resume production, since the current level of £900 plus per ton is considered economic for marginal mines to operate.

Exporting to East Africa

Aimed particularly at exporters new to the area, a survey on marketing and publicity in East Africa, published by the Board of Trade Journal, gives topographical, economic and political information about Kenya, Uganda and Tanganyika. It tells how to tackle the market, advises on local advertising methods, and on choosing an agent. It shows the distribution of local purchasing power, gives information about inland freight services and charges, and sums up the market for both consumer and capital goods. There is information about trading conditions in the area and statistics showing local imports and exports. Future development and the present location of industry are also featured. There are maps and tables of interest to exporters and the survey is illustrated with photographs which portray something of the challenge of the market. The survey, in reprint form, is available on request, free of charge, from the Export Publicity and Fairs Branch, Board of Trade, Horse Guards Avenue, London, S.W.1.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange official warehouses at the end of last week fell 218 tons to 5,701 tons, comprising London 2,635, Liverpool 1,770, and Hull 1,296 tons.

Copper stocks fell 50 tons to 21,789, comprising London 675, Liverpool 17,064, Birmingham 50, Manchester 3,925, Hull 50 and Glasgow 25.

Lead duty-free stocks rose 450 tons to 7,606 tons, comprising London 7,331, Glasgow 100, and Swansea 175 tons. In-bond stocks remained unchanged at 2,802 tons (all in London).

Zinc duty-free stocks fell 210 tons to 3,866, comprising London 2,647, Glasgow 126, Hull 375, Manchester 400 and Liverpool 318 tons. In-bond stocks remained unchanged at 2,935 (all in London).

Institution of Metallurgists

Examinations for the Associateship and Licentiateship of **The Institution of Metallurgists,** 1961, were held in July last at fourteen examination centres in the U.K. and twelve centres abroad. For Associateship, 142 of the 341 candidates presenting themselves passed and 119 were referred in one subject. For Licentiateship, 196 of the 731 candidates presenting themselves passed and 132 were referred.

Summer School in Microanalysis

Scientists from many parts of the world who visited the laboratories and works of the **Cambridge Instrument Company** on Tuesday, July 25, saw several Microscan X-ray analysers in various stages of construction and examined the greatly expanded production facilities for dealing with current Microscan orders. The Microscan is a commercial X-ray microanalyser; sixteen have been installed within the past 18 months in British, American, Dutch and German research and development organizations.

The visitors were delegates from a summer school on X-ray microanalysis which was held in Cambridge, from July 24 till August 4, under the auspices of the University Board of Extra-Mural Studies. The school was convened by Dr. V. E. Cosslett of the Cavendish Laboratory, who has directed important fundamental work in X-ray microanalysis and is well known for his research into the principles and applications of both X-ray analysis and electron-microscopy.

In addition to the visit to the Cambridge Instrument Company, the agenda included a visit to Tube Investments Research Laboratories, opportunities for practical work, lectures describing the development applications and general principles of the technique, and surveys of commercially available instruments. Lecturers included Dr. Cosslett, Professor R. Castaing of France, the originator of the technique; Mr. T. Mulvey, of AEI Research Laboratories; Professor R. E. Ogilvie, of Massachusetts Institute of Technology, Drs. D. A. Melford and P. Duncumb, of Tube Investments Research Laboratories, and Dr. Nixon, of the University Engineering Laboratory.

Forthcoming Meetings

September 4 — Society of Instrument Technology. South Yorkshire Section. University Department of Fuel Technology, Mappin Street, Sheffield. "Automatic Gauge Control." P. R. A. Briggs. 7 p.m.

September 5—Institute of Metal Finishing. Midland Branch. James Watt Memorial Institute, Great Charles Street, Birmingham. "The Modern Plating Shop—Theory and Practice." J. Chadwick. 6.30 p.m.

September 5 — Institution of Plant Engineers. London Branch. Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2. "Corrosion —Prevention by Cathodic Protection." R. A. Lowe. 7 p.m.

September 6—Institute of Metal Finishing. Scottish Branch. Grand Hotel, Charing Cross, Glasgow. "Trouble Shooting in the Plating Shop." J. C. Carder. 7.30 p.m.

New D.S.I.R. Headquarters

As from August 30, the headquarters of the Department of Scientific and Industrial Research, formerly at Charles House, 5-11 Regent Street, London, S.W.1, is to be at State House, High Holborn, London, W.C.1, telephone Chancery 1262. State House is a new 15-storey block about three minutes' walk from Holborn underground station on the north side of High Holborn.

Foil Factory for Greece

Four million dollars is to be invested by the Greek "Viochalko" Copper and Aluminium Company (Industrie Hellenique du Cuivre et Aluminium) in the construction of an aluminium foil factory near Athens.

Capacity of the plant will be 1,200 tons/yr., double that of present local consumption, thus leaving an adequate surplus for export. The plant is expected to be completed in 1965.

The new factory will form a branch of the existing installations of "Viochalko", which manufactures aluminium products, including sheets, discs, wires, and cables.

Long-Life Press Tools

Used in the continuous production of steel ferrules for the electrical industry, several "Cutanit" press drawing dies have produced up to five million components without service at the works of F. C. Blackwell and Co. Ltd., Liverpool. One put into use in 1949 has produced 18 million components and is still working. "Cutanit" is distributed by **Jessop-Saville (Small Tools) Ltd.**

Continuous Casting Plant

A vertical type continuous casting plant, built by Schloemann Aktiengesellschaft, Düsseldorf, in association with Concast Aktiengesellschaft, Zürich, was recently taken into commission by the Dillinger

Steelworks. The plant is to be employed for the casting of slabs to serve as starting material for the manufacture of plate and strip.

Development in North-East England

Containing a review of the work of the **North-East Industrial and Development Association,** the annual report of that body for 1960-61 was published this week. The report also contains details of member firms, local authorities concerned, and a "Review of Economic and Industrial Conditions on the North-East Coast", by W. R. Snaith. It is published from 9 Eldon Square, Newcastle upon Tyne, 1.

Radiation Shielding

Outlining the properties of lead, and in particular those that recommend it for use in radiation shielding, a booklet entitled "Lead for Radiation Protection" has been issued by **Associated Lead Manufacturers Ltd.,** 14 Gresham Street, London, E.C.2. The booklet illustrates and describes some of the applications of lead, as in bricks for manipulation chambers, in reactor shielding, in machined lead components, and in lead-polythene tubing. It also gives a series of data on shielding and the testing of lead shields.

Compressed Air Engineering

An international technical advice bureau to provide information on compressed air engineering, is being opened at 11 Clarges Street, London, W.1, by **Atlas Copco (Gt. Britain) Ltd.** Manager of this international division, as it will be called, will be Mr. W. L. Fairless.

Safety in Foundries

Using his powers under the Factories Act, 1959, the Minister of Labour has reappointed the Joint Standing Committee on Health, Safety, and Welfare in non-ferrous foundries.

Mr. H. Woods, C.B.E., H.M. Deputy Chief Inspector of Factories, has been appointed chairman, and the other members are:—Mr. C. W. Hallett (Amalgamated Engineering Union; Mr. W. Prince (Amalgamated Union of Foundry Workers); Mr. E. Ayres and Mr. P. B. Higgins (Association of Bronze and Brass Founders); Mr. H. G. Barratt (Confederation of Shipbuilding and Engineering Unions); Mr. F. G. Burrell, O.B.E., and Mr. C. E. Watson (Engineering Employers' Federation); Dr. W. D. Buchanan, B.Sc., M.B., Ch.B., D.P.H., H.M. Deputy Senior Medical Inspector of Factories; Mr. J. Gardner (independent member); Mr. E. Tullock (Iron, Steel and Metal Dressers and Kindred Trades Society); Mr. A. Graham (Light Metal Founders' Association); Mr. R. W. Salt (National Society of Metal Mechanics); Mr. J. H. Barwell, J.P., and Mr. L. W. Gummer, M.I.Mech.E. (The National Brassfoundry Association); Mr. G. W. Chilton (The North of England Brass Moulders' Trade and Friendly Society); Mr. W. Lapworth (Transport and General Workers' Union); and Mr. A. E. Mills (Zinc Alloy and Diecasters' Association). The secretary is Mr. W. B. Lawrie, H.M. Engineering Inspector of Factories.

Smelter for Trinidad

An agreement between Paul Bergsoe and Son, smelters of non-ferrous metals with headquarters in Denmark, and British Batteries Overseas Ltd., manufacturers of Lucas, Dagenite and Exide batteries, has been reached to make batteries and smelt non-ferrous metals on a joint basis in Trinidad, according to a report from Port-of-Spain.

Batteries made by the proposed concern will be exported throughout the Caribbean. Products of the smelting operations such as brass, and copper ingots, which will employ scrap obtained from Puerto Rico, Venezeula and other South American countries, will be exported to the United States.

Productivity in Welding

During the past two months, a Productivity Team on Welding from the National Productivity Council of India has been visiting Japan, the U.S.A. and West Germany; at the invitation of the **Institute of Welding** it was visiting Great Britain during the week August 21-25.

The objective of the team's world tour was to study the use of welding in the countries visited, with a view to finding out how industrial productivity in India can be improved through greater and better use of welding.

Extruded Copper Products

A new addition to the existing wide range of **Copper Development Association** publications, No. 59, "Extruded Copper and Copper Alloy Products", now provides the essential basic information on the properties, manufacture and potentialities of the exceptionally wide range of shapes and sizes of rods and sections which is now available in a variety of copper-base metals. Many typical applications are illustrated, and by emphasizing the technical and economic advantages it is hoped that this booklet will contribute to an even wider appreciation of the value and uses of extruded copper and copper alloy products. Comprising 72 pages and profusely illustrated, this publication is available free upon request from C.D.A., 55 South Audley Street, London, W.1.

Light Metal Statistics

Figures showing the U.K. production, etc., of light metals for June 1961 have been issued by the Aluminium Industry Council as follows (in long tons):—

Virgin Aluminium	
Production	2,728
Imports	15,985
Despatches to consumers	20,590
Secondary Aluminium	
Production	11,446
Virgin content of above	1,151
Despatches (including virgin content)	11,436
Scrap	
Arisings	13,776
Estimated quantity of metal recoverable	10,370
Consumption by:	
(a) Secondary smelters	13,000
(b) Other uses	1,132
Despatches of wrought and cast products	
Sheet, strip and circles	15,379
Extrusions (excluding forging bar, wire-drawing rod and tube shell):	
(a) Bars and sections	3,911
(b) Tubes (i) extruded	437
(ii) cold drawn	627
(iii) formed strip	—
(c) (i) Wire	1,586
(ii) Hot rolled rod (not included in (c) (i))	58
Forgings	346
Castings: (a) Sand	1,674
(b) Gravity die	4,542
(c) Pressure die	2,337
Foil	2,514
Paste	339

Chemical Group Survey

A comprehensive account of the character and activities of the Albright and Wilson group of chemical companies as it is today is given in a new book, "Survey of a Chemical Group", published by **Albright and Wilson Ltd**.

The book shows how a number of companies, each with its own chronicle of success, have integrated to make the Albright and Wilson group a rapidly expanding organization whose diverse fields of operation are world wide.

Representative of a group with a forward-looking policy, the book only briefly sketches past history and concentrates on the present organization, its services and products.

Stocktaking on Management Education

A conference was held at the Federation of British Industries earlier this year to discuss Stocktaking on Management Education and plans for the future. The conference provided an opportunity for a review of what has been done in the past decade at the Administrative Staff College; what has been achieved by management consultants; and the work of the universities, technical colleges, and the British Institute of Management.

The report of this conference has now been published, entitled "Stocktaking on Management Education", and is obtainable from F.B.I. Print and Publications, 21 Tothill Street, London, S.W.1, price 10s. post free (excluding air mail).

Copper in Chile

Last week, the Lower Chamber of the Chilean Parliament passed a motion appointing a commission to investigate the "economic damage" caused by the present tax system applied to major copper companies. A resolution asking the Finance Minister to report on whether advertising costs of the companies were included in production costs to reduce taxes was also approved. The Chamber passed a third motion asking for a report on contributions by copper companies to reconstruction of the southern areas of Chile damaged by earthquakes in May last year.

Present problems and the future outlook of the Chilean copper industry are to be discussed by Dr. Enrique Serrano, Chilean Minister of Mines, and Charles M. Brinckerhoff and Frank R. Milliken, Presidents, respectively, of the Anaconda Company and Kennecott Copper Corporation, who were due to meet in Santiago on August 28 for talks.

Japanese Aluminium Venture

A spokesman for the Yawata Iron and Steel Company stated in Tokyo last week that the company was negotiating a joint project for an aluminium rolling mill with an American aluminium producer. He did not identify the firm. A Yawata executive had recently returned from the

United States, where he had reached an "agreement in principle" with the U.S. firm on the project. A representative of the American company was expected there this month to discuss details and finalize the agreement.

The American company would take a one-third stake in the stock of a new 2,000,000,000 yen capital company, the spokesman said. Yawata and two other Japanese firms—Kinoshita Sansho Trading Company and the Nisso Seiko Company—would put up the rest of the capital. The new company would import primary aluminium from the U.S. company, and also use Japanese output.

A Link-up

It is reported that **Electro Mechanisms Ltd.**, one of the King group of companies, which also includes S.F.I.M. (Great Britain) Ltd. and Flexonics Ltd., has announced its link with Schaevitz Engineering of Schaevitz Boulevard, Pennsauken, New Jersey, U.S.A. The existing directors of Electro Mechanisms, namely Sir Harold T. Lydford, K.B.E., C.B., A.F.C.; D. M. Read, A.R.Ae.S.; J. Staples; W. E. Cole; S. H. Parsonage, A.M.I.E.E.; are now joined by Herman Schaevitz (U.S.A.) and Louis Bernant (U.S.A.).

The Electro Mechanisms range of transducers and amplifiers will now be strengthened by the Schaevitz range of linear and rotary differential transformers, dynamometers, transducers and the full range of the Schaevitz centrifuges. The agreement between the companies provides for the fullest exchange of all technical information in the field of common interest.

Japanese Rolled Products

Output of rolled aluminium products in June reached an all-time high at 12,486 metric tons compared with the previous record of 12,477 tons in February, according to the Japanese Light Metal Rollers' Society. Deliveries slightly increased over those in May, but stocks were up at the end of June, reflecting the increased output.

Figures in June and May (in parentheses) were as follows (all in metric tons): output 12,786 (12,361), deliveries 12,554 (12,182), end-month stocks 3,936 (3,483).

Main destinations were as follows (in metric tons): U.S. 357, Vietnam 142, Thailand 64, Korea 34, Indonesia 24, Malaya 20, Pakistan 19, Philippines 19, Okinawa 18, Hong Kong 14.

Export contracts for rolled aluminium products in June totalled 531 metric tons, compared with 743 in May, and the exports shipments in June totalled 732 tons compared with 807 tons in May.

Rolled copper and copper-base alloy production in June was 26,100 tons, a new record, exceeding by 821 the May production, which was the previous highest production level, according to the Japanese Brass Makers' Association.

The association said the exports of rolled copper in June totalled 533 tons, as compared with 641 in May. Export contracts during June totalled 619 tons. A breakdown of rolled copper and copper-base alloy production figures is as follows: Output — copper 7,619, brass 17,601, bronze 560, nickel silver 325. End-of-month stocks: copper 1,640, brass 3,600, bronze 218, nickel silver 73. Deliveries: copper 7,625, brass 17,164, bronze 539, nickel silver 326.

Main destinations of shipments during June were: U.S. 161, Hong Kong 160, Thailand 60, Philippines 32, Formosa 24, South Vietnam 20.

Company Reports

Antiference Group

Group net profit £187,679 (£247,506), and dividend 40 per cent (same) on unrestricted Ordinary. Fixed assets £508,380 (£486,417), current assets £1,829,073 (£1,448,558), and liabilities £654,921 (£405,664). Commitments £37,600.

E. Austin and Sons (London)

Group net loss year ended March 31, 1961, £39,121 (profit £16,173) and no dividend (4 per cent plus 2 per cent capital distribution). Fixed assets £506,375 (£454,814), current assets £490,746 (£424,521) and liabilities £396,290 (£236,387) including bank overdraft £175,478 (£83,217). Outstanding commitments £35,000 (£5,000).

Beralt Tin and Wolfram

Profits rose from £212,864 to £241,067, and after tax of £88,937 (£85,415) there is a net balance of £152,130 (£127,449). Transfer of £46,736 to reserve restores that fund to £300,000. A 60 per cent dividend with a final of 40 per cent for the year ended March 31, 1961, has been declared.

Cope Allman and Co.

Group profit year ended March 1961 expanded from £220,594 to £333,060 and, after tax, the net balance was £160,499 (£118,476). To reserves £6,500 (£27,205), forward £196,741 (£113,395). During the year the capital and surplus rose from £674,241 to £1,195,041. A final dividend has been announced of 12½ per cent, making a total equal to 21¾ per cent for the year ended March 31, 1961, compared with the equivalent of 18¾ per cent previously.

Manley and Regulus Ltd.

Group net surplus 1961, £25,004 (£3,017), and dividend 12½ per cent (same). Fixed assets £263,393 (£266,846), investments £122,253 (£130,258), and current assets £553,530 (£471,135). Current liabilities £345,090 (£252,172), including bank overdraft £165,534 (£90,880).

Thos. Firth and John Brown

The purchase and cancellation of £93,496 Debenture stock by the company leaves £2,743,754 in issue.

New Companies

Storey Metal Industries Limited (697837), Lingard Lane, Bredbury, Ches. Registered July 10, 1961. Nominal capital, £250,000 in 5s. shares. Directors: Thomas Storey and Mrs. Margaret E. Storey.

Scrap and Demolition (Leeds) Limited (698283), 67 High Street, Lewes, Sussex. Registered July 13, 1961. To carry on business of scrap metal merchants, etc. Nominal capital, £100 in £1 shares. Director: Desmond J. Langman.

A. F. Hayes and Co. Limited (699135), Clarkes Road, Wigston, Leicester. Registered July 24, 1961. To carry on business of metal finishers, etc. Nominal capital, £1,000 in £1 shares. Directors: Albert F. Hayes and Wm. C. Hayes.

Metal Disposals Limited (699233), Lombard House, Great Charles Street, Birmingham. Registered July 25, 1961. To carry on business of scrap metal merchants, etc. Nominal capital, £100 in £1 shares. Directors to be appointed by subscribers.

Finchley Metal Company Limited (699281), 65 Highgate High Street, N.6. Registered July 25, 1961. Nominal capital, £100 in £1 shares. Directors: Kenneth K. Powell and Mrs. Eileen E. Powell.

Camberley Metal Polishers Limited (699658), 22 Manor Way, Bagshot, Surrey. Registered July 31, 1961. Nominal capital, £200 in £1 shares. Directors: Robt. J. Towers and Arthur G. Amos.

G. and E. Aluminium Flashings Limited (699666), 24 Nelsons Row, S.W.4. Registered July 31, 1961. Nominal capital, £100 in £1 shares. Directors: Gordon M. Carrick and John S. Manuel.

Trade Publications

Welding News. — Suffolk Iron Foundry (1920) Ltd., Sifbronze Works, Stowmarket, Suffolk.

The summer number of "Sif-Tips" contains several informative articles well illustrated with valuable pictures and diagrams. One technical article deals with the major part that welding has to play in fabricating the bodywork of refrigerators. Another interesting feature is an argument for and against preheating in welding operations, as well as an article about the manufacture of petrol and diesel fuel pumps in so far as welded and brazed joints are required for these products.

Grinding Carbide Turning Tools.—Production Engineering Research Association, Melton Mowbray, Leics.

This is a 16-page brochure published by the association providing a comparative study of methods into grinding carbide turning tools. Various methods of grinding carbide lathe tools have been investigated with particular reference to tool life. The brochure gives conclusions and recommendations, and also deals with equipment, methods, results and references. A number of photographs and diagrams are included. Copies of this research report are available from the association at the price of 7s. 6d.

Heat Transfer Medium. — Imperial Chemical Industries Limited, Heavy Organic Chemicals Division, Millbank, London, S.W.1.

This brochure is devoted to a detailed explanation of the use of "Thermex" as a heat transfer medium. Its physical characteristics, thermal stability, application and typical uses are accompanied by statistical charts, diagrams, etc.

Metal Market News

WHILE copper last week moved within fairly narrow limits, with lead in a similar category, the price of tin advanced in a spectacular fashion. Zinc lost ground and this metal appears to have few friends at the present time. In copper there was a tendency for the contango to narrow during the second half of the week. The pattern of change in L.M.E. stocks was largely unaltered as to the various metals. In the case of standard copper there was an advance of 98 tons to 21,839 tons, while stocks of zinc also improved by 752 tons to 7,011 tons, which compares with 1,919 tons at the beginning of the year. Incidentally, it may be mentioned that the reserves of copper have come up from 14,334 tons reported on January 3 last to the present total, which stands around 22,000 tons.

The fall in the stocks of tin goes on, last week's report giving a total of 5,919 tons, which was 92 tons down. Reserves of tin, which at the beginning of the year stood at about 9,500 tons, have risen above 10,000 tons during the year but are now down to 5,919 tons. Stocks of lead last week were reported 291 tons down at 9,958 tons. At the beginning of the year, L.M.E. warehouse stocks of lead stood at about 6,900 tons, but by mid-July they had risen to over 13,000 tons, since when there has been a pretty steady falling away and the trend seems still to be downwards.

Markets were rather more active last week, and it may well be that we are beginning to pull out of the summer holiday hiatus. At the time of writing, however, in spite of the firmer tendency of the copper market, consumers have not abandoned their cautious waiting attitude, and so long as they stick to this the rise cannot go very far. The extremely unsatisfactory news from Chile, where the labour situation last week seemed to be getting out of hand, naturally acted as a prop to the copper markets in London and New York. As already mentioned, the users have not so far shown their hand and it must be presumed that they feel satisfied with their supply position. The existence of an L.M.E. stock of nearly 22,000 tons is certainly an encouragement to them, but if a scramble should start then things might be rather difficult. "Free" wirebars are still relatively scarce and on the Continent it is reported that fairly substantial premiums are still being paid.

In standard copper there was a turnover of some 13,150 tons, cash gaining £2 to close at £232 while three months was up by 30s. at £234 15s. 0d. At one time the cash quotation dropped to £229 and three months to £232 10s. 0d., but this proved to be the bottom. The turnover for the week comprised a fair proportion of "carries". In the face of the continuation of the strike, the comparative weakness of the market during the first part of the week was puzzling and can only be explained by the lack of enthusiasm by consumers.

Tin was again very firm, prices advancing almost daily to close £28 up for cash and £23 10s. 0d. for three months at £967 and £973. Turnover was 1,700 tons. Much higher values are looked for, and a figure of £1,200 has been mentioned as a possibility. On a turnover of 10,000 tons, lead closed 30s. up at £65 10s. 0d. cash and £67 three months. In zinc, some 5,000 tons changed hands, with pronounced weakness in the quotation which closed £2 down at £74 17s. 6d. cash and £75 15s. 0d. forward.

New York

Towards the close of last week, copper futures were barely steady on scattered selling in fair dealings, but were firmer on Friday on covering and new buying in fair dealings. In physical copper, dealers noted quiet conditions with the export market barely steady, but steadier conditions prevailed on Friday.

Early this week copper futures extended their recent upward tendency, gaining about 20 points, but activity was only modest. Physical copper was quiet but the custom smelters and large producers' price was quite firm at 31 cents per lb. Scrap copper was tight but the price held.

Lead was modestly active. Prime western zinc was active while special grade continued to lag. Tin was firm. Dealer-to-dealer business was reported early at prices ranging to 123¼ cents for spot and positions to the end of December, and small dealer to consumer business at 123½ cents.

Zurich

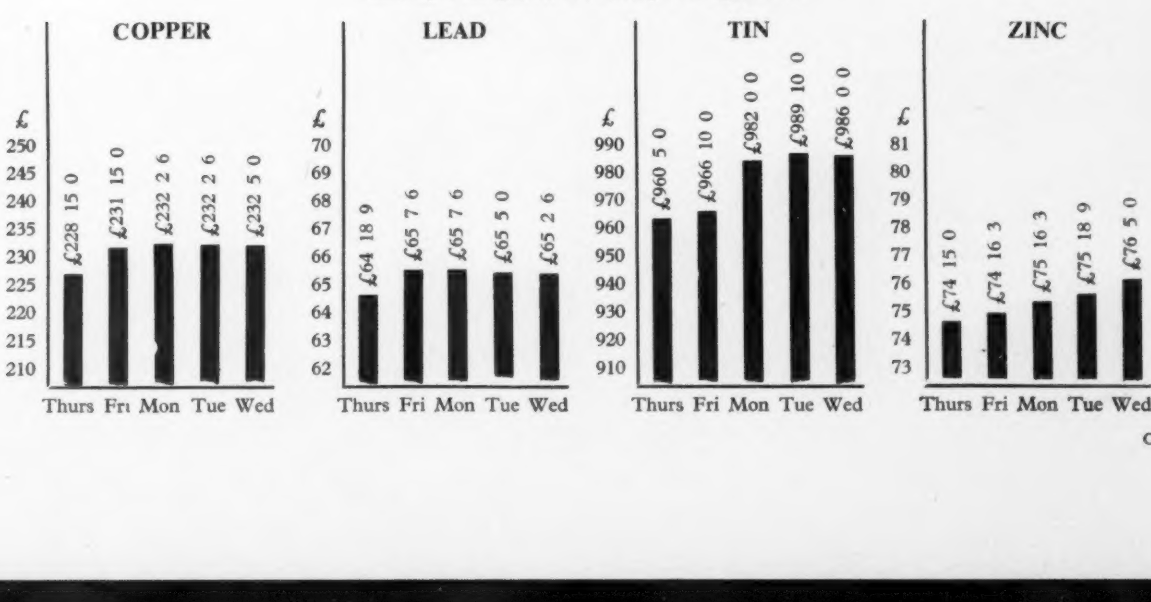
Considerable increases in industrial demand for gold and silver during the week to August 23 were recorded. The turnover in platinum and palladium was stable.

According to trade reports, offerings of platinum and palladium were stronger while offerings of gold and silver decreased slightly. Accordingly, gold and silver quotations advanced while platinum and palladium quotations were easier.

Average prices were unchanged as follows on August 23 (in Swiss francs per kilo): gold 4,900, silver 131·75, platinum 10,875, palladium 3,100, iridium 9,000-10,500, ruthenium 7,000-8,500, rhodium 19,000-20,000, osmium 9,500-12,500.

London Metal Exchange

Thursday 24 August to Wednesday 30 August 1961



NON-FERROUS

PRIMARY METALS

All prices quoted are those available at 2 p.m. 30/8/61

		£	s.	d.
Aluminium Ingots	ton	186	0	0
Antimony 99·6%	„	237	10	0
Antimony Metal 99%	„	230	0	0
Antimony Oxide				
Commercial	„	194	10	0
Antimony White Oxide	„	212	0	0
Arsenic	„	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	„		11	0
Calcium	„	2	0	0
Cerium 99%	„	15	0	0
Chromium	„		6	11
Cobalt	„		12	0
Columbite per unit		8	0	0
Copper H.C. Electro	ton	232	5	0
Fire Refined 99·70%	„	231	0	0
Fire Refined 99·50%	„	230	0	0

		£	s.	d.
Copper Sulphate	ton	78	0	0
Germanium	grm.		—	
Gold	oz.	12	10	11
Indium	„		10	0
Iridium	„	24	0	0
Lanthanum	grm.		15	0
Lead English	ton	65	2	6
Magnesium Ingots	lb.			
99·8%	„		2	2½
99·9+%	„		2	3
Notched Bar	„		2	9½
Powder Grade 4	„		5	6
Alloy Ingot, AZ91X		1	11¾-2	1¼
Manganese Metal	ton	280	0	0
Mercury	flask	63	0	0
Molybdenum	lb.	1	15	0
Nickel	ton	660	0	0
F. Shot	lb.		5	11
F. Ingot	„		5	11
Osmium	oz.	20	0	0
Osmiridium	„		—	

		£	s.	d.
Palladium	oz.	9	0	0
Platinum	„	30	5	0
Rhodium	„	46	0	0
Ruthenium	„	16	0	0
Selenium	lb.	2	6	6
Silicon 98%	ton	123	0	0
Silver Spot Bars	oz.		6	7¾
Tellurium Sticks	lb.	2	0	0
Tin	ton	986	0	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	76	14	4½
Dust 95/97%	„	121	10	0
Dust 98/99%	„	127	10	0
Granulated 99+%	„	101	14	4½
Granulated 99·99+%	„	114	6	3

**Duty and Carriage to customers' works for buyers' account.*

INGOT METALS

All prices quoted are those available at 2 p.m. 30/8/61

Aluminium Alloy (Virgin)		£	s.	d.
B.S. 1490 L.M.5	ton	210	0	0
B.S. 1490 L.M.6	„	202	0	0
B.S. 1490 L.M.7	„	216	0	0
B.S. 1490 L.M.8	„	203	0	0
B.S. 1490 L.M.9	„	203	0	0
B.S. 1490 L.M.10	„	221	0	0
B.S. 1490 L.M.11	„	215	0	0
B.S. 1490 L.M.12	„	223	0	0
B.S. 1490 L.M.13	„	216	0	0
B.S. 1490 L.M.14	„	224	0	0
B.S. 1490 L.M.15	„	210	0	0
B.S. 1490 L.M.16	„	206	0	0
B.S. 1490 L.M.18	„	203	0	0
B.S. 1490 L.M.22	„	210	0	0
Aluminium Alloys (Secondary)				
B.S. 1490 L.M.1	ton	152	0	0
B.S. 1490 L.M.2	„	152	0	0
B.S. 1490 L.M.4	„	161	0	0
B.S. 1490 L.M.6	„	176	0	0
***Aluminium Bronze**				
BSS 1400 AB.1	ton	243	0	0
BSS 1400 AB.2	„	251	0	0

***Brass**		£	s.	d.
BSS 1400-B3 65/35	ton	177	0	0
BSS 249	„		—	
BSS 1400-B6 85/15	„	224	0	0
***Gunmetal**				
R.C.H. 3/4% ton	„		—	
(85/5/5/5) LG2	„	219	0	0
(86/7/5/2) LG3	„	229	0	0
(88/10/2/1)	„	291	0	0
(88/10/2/½)	„	301	0	0
***Manganese Bronze**				
BSS 1400 HTB1	„	195	0	0
BSS 1400 HTB2	„	215	0	0
BSS 1400 HTB3	„	230	0	0
Nickel Silver				
Casting Quality 12%	„	265	0	0
„ „ 16%	„	280	0	0
„ „ 18%	„	310	0	0
***Phosphor Bronze**				
B.S.1400P.B.1.(A.I.D. released)	„	319	0	0
B.S. 1400 L.P.B.1	„	242	0	0

**Average prices for the last week-end.*

Phosphor Copper		£	s.	d.
10%	ton	257	0	0
15%	„	260	0	0
Phosphor Tin				
5%	„	1020	0	0
Silicon Bronze				
BSS 1400-SB1	„	275	0	0
Solder, soft, BSS 219				
Grade C Tinmans	„	445	0	0
Grade D Plumbers	„	352	0	0
Grade M	„	491	0	0
Solder, Brazing, BSS 1845				
Type 8 (Granulated)	lb.		—	
Type 9 „	„		—	
Zinc Alloys				
BSS 1004 Alloy A	ton	107	16	3
BSS 1004 Alloy B	„	111	16	3
Sodium-Zinc	lb.		2	6½

SCRAP METALS

Merchants' average buying prices delivered, per ton, 29/8/61

Aluminium	£
New Cuttings	139
Old Rolled	104
Segregated Turnings	78
Brass	
Cuttings	161
Rod Ends	144
Heavy Yellow	137
Light	132
Rolled	147
Collected Scrap	134
Turnings	138

Copper	£
Wire	207
Firebox, cut up	205
Heavy	204
Light	201
Cuttings	212
Turnings	188
Braziery	168
Gunmetal	
Gear Wheels	200
Admiralty	200
Commercial	180
Turnings	175

Lead	£
Scrap	54
Nickel	
Cuttings	—
Anodes	590
Phosphor Bronze	
Scrap	180
Turnings	175
Zinc	
Remelted	69
Cuttings	60
Old Zinc	39

METAL PRICES

SEMI-FABRICATED PRODUCTS

Prices vary according to dimensions and quantities. The following are the basis prices for certain specific products

Aluminium				£	s.	d.
Sheet	10	S.W.G.	lb.		2	10½
Sheet	18	S.W.G.	„		3	0½
Sheet	24	S.W.G.	„		3	3½
Strip	10	S.W.G.	„		2	10½
Strip	18	S.W.G.	„		2	11½
Strip	24	S.W.G.	„		3	1
Circles	22	S.W.G.	„		3	4½
Circles	18	S.W.G.	„		3	3½
Circles	12	S.W.G.	„		3	2½
Plate as rolled			„		2	10
Sections			„		3	4
Wire 10 S.W.G.			„		3	1½
Tubes 1 in. o.d. 16 S.W.G.			„		4	4
Aluminium Alloys						
BS 1470. HS19W.						
Sheet	10	S.W.G.	„		3	3
Sheet	18	S.W.G.	„		3	5½
Sheet	24	S.W.G.	„		4	1
Strip	10	S.W.G.	„		3	3
Strip	18	S.W.G.	„		3	4½
Strip	24	S.W.G.	„		4	0½
BS1477. HP30M.						
Plate as rolled			„		3	1
BS1470. HC15WP.						
Sheet	10	S.W.G.	„		4	3
Sheet	18	S.W.G.	„		4	8½
Sheet	24	S.W.G.	„		5	8½
Strip	10	S.W.G.	„		4	4
Strip	18	S.W.G.	„		4	8½
Strip	24	S.W.G.	„		5	4½

Aluminium Alloys—cont.		£	s.	d.
BS1477. HPC15WP.				
Plate heat treated	lb.		3	10½
BS1475. HG19W.				
Wire 10 S.W.G.	„		4	2
BS1471. HT19WP.				
Tubes 1 in. o.d. 16 S.W.G.	„		5	5
BS1476. HE19WP.				
Sections	„		3	4
Split tube				
19 S.W.G. (½")	„		4	2
20 S.W.G. (⅜")	„		3	11
21 S.W.G. (⅜")	„		4	1
22 S.W.G. (¼")	„		4	11
Welded tube				
14 to 20 S.W.G. (sizes ½" to 1½")	„	3/10½ to 5/8½		
Brass				
Tubes	lb.		1	9⅞
Brazed Tubes	„		3	2¼
Drawn Strip Sections	„		3	2¼
Sheet	ton	198	15	0
Strip	„	198	15	0
Extruded Bar	lb.		2	0⅜
Condenser Plate (Yellow Metal)	ton	186	0	0
Condenser Plate (Naval Brass)	„	199	0	0
Wire	lb.		2	8½

Beryllium Copper		£	s.	d.
Strip	lb.	1	4	11
Rod	„	1	1	6
Wire	„	1	4	9
Copper				
Tubes	lb.		2	2⅝
Sheet	ton	265	5	0
Strip	„	265	5	0
H.C. Wire	„	282	15	0
Cupro Nickel				
Tubes 70/30	lb.		3	8⅝
Lead				
Pipes (London)	ton	107	0	0
Sheet (London)	„	104	15	0
Tellurium Lead	„	£6 extra		
Nickel Silver				
Sheet and Strip 10%	lb.		3	11¼
Wire 10%	„		4	4½
Phosphor Bronze				
Wire	„		4	2½
Titanium (1,000 lb. lots)				
Billet 4½" to 18" dia.	lb.	47/-	48/-	
Rod ¼" to 4" dia.	„	85/-	53/-	
Wire ·036"-·232" dia.	„	159/-	99/-	
Strip ·001" to ·048"	„	350/-	68/-	
Sheet 8'×2'. 20 gauge	„	73/-		
Tube, representative average gauge	„	198/-		
Extrusions	„	90/-		
Zinc				
Sheet	ton	113	12	6
Strip	„	nom.		

FOREIGN QUOTATIONS

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

Belgium	fr/kg	£/ton	
Copper: electrolytic	31.75	232	1
Tin	138.40	1,011	10
Canada	c/lb	£/ton	
Aluminium	26.00	210	12
Copper: electrolytic	30.00	243	0
Lead	10.50	81	0
Nickel	70.00	567	0
Zinc: Prime western	12.00	97	4
High grade 99.95	12.60	102	1
High grade 99.99	13.00	105	6
France	fr/kg	£/ton	
Aluminium	2.43	179	11
Antimony 99·0	2.80	206	18
Cadmium	16.25	1,200	17
Copper: electrolytic	3.21	237	5
Lead	.95	70	4
Nickel	9.00	665	2
Tin	14.10	1,042	0
Zinc: Thermic	1.14	84	4
Zinc: electrolytic	1.22	90	3
Scrap			
Copper: electrolytic	2.85	210	12
Heavy copper	2.85	210	12
No. 1 copper wire	2.70	199	10
Brass rod ends	2.10	155	3
Zinc castings	.90	66	10
Lead	.87	64	5
Aluminium	1.75	129	6

Italy	lire/kg	£/ton	
Aluminium	370	216	1
Antimony 99·0	485	283	4
Copper: wire bars 99.9	450	262	16
Lead	165	96	8
Nickel	1,300	805	14
Tin	1,750	1,022	0
Zinc: electrolytic	181	105	15
Scrap			
Aluminium soft sheet clippings (new)	305	178	2
Lead, soft, first quality	137	80	0
Lead, battery plates	77	45	19
Copper, first grade	370	216	0
Bronze, commercial gunmetal	410	239	8
Brass: heavy	275	160	12
Brass: light	260	152	16
Brass, bar turnings	275	160	12
Old zinc	105	61	6
Switzerland	fr/kg	£/ton	
Aluminium	2.50	210	5
Copper: electrolytic	2.90	243	17
Lead	.80	67	5
Nickel	7.50	630	15
Tin	11.20	942	0
Zinc: High grade 99.99	1.04	87	10

Japan	Yen per metric ton
Scrap	
Copper: electrolytic	292,000
Copper wire No. 1	270,000
Copper wire No. 2	268,000
Heavy copper	260,000
Light copper	237,000
Brass, new cuttings	198,000
Red brass scrap	215,000

West Germany *Scrap*	D-marks per 100 kilos	£/ton	
Used copper wire	225	205	0
Heavy copper	220	200	8
Light copper	190	173	1
Heavy brass	145	132	1
Light brass	110	100	5
Soft lead	50	45	11
Zinc	50	45	11
Used aluminium unsorted	75	68	6
United States	c/lb	£/ton	
Aluminium	26.00	207	4
Antimony 99·0	32.50	259	0
Cadmium	160.00	1,275	4
Copper: electrolytic	31.00	247	10
Lead	11.00	87	13
Nickel	81.25	647	11
Tin	123.50	984	5
Zinc: electrolytic	12.50	99	12

THE STOCK EXCHANGE

No Improvement In Prices Or Business

ISSUED CAPITAL ⊕	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 28 Aug. +RISE—FALL		DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1961 HIGH	1961 LOW	1960 HIGH	1960 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation	32/6	+1/3	11	9	6 15 6	33/9	26/3	35/-	26/6
400,000	2/-	Anti-Attrition Metal	1/3		NIL	4	NIL	1/3⅜	0/9	1/6	0/9
43,133,593	Stk. (£1)	Associated Electrical Industries	35/-	—3d.	15	15	8 11 6	54/10½	35/-	67/3	38/3
3,895,963	1	Birfield	61/6		10	15‡	3 5 0	78/9	45/-	51/3	29/-
4,795,000	1	Birmid Industries	76/6	+6d.	20	20D	5 4 6	103/-	71/3	74/9	56/-
8,445,516	Stk. (10/-)	Birmingham Small Arms	21/9	—1/-	17½QT	12½	5 7 3	36/10½	20/6	30/6	18/3
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	14/-		5	5	7 2 9	14/6	13/1½	17/4½	14/9
476,420	Stk. (£1)	Ditto Cum. B. Pref. 6%	16/-		6	6	7 5 6	17/6	15/6	20/-	17/1½
1,500,000	Stk. (£1)	British Aluminium Co. Pref. 6%	15/9		6	6	7 10 0	18/-	15/3	21/1½	17/7½
18,846,647	Stk. (£1)	British Insulated Callender's Cables	57/6	—1/-	13½	13½	4 14 0	62/3	49/-	61/4½	47/-
7,670,837	5/-	British Oxygen Co. Ltd., Ord.	18/3	—3d.	16D	16	2 18 3	28/4½	17/6	35/-	19/10½
1,200,000	Stk. (5/-)	Canning (W.) & Co.	16/3	+9d.	15⅝	25+*2½C‡	4 19 6	20/9	13/7½	19/9	13/7½
60,484	1/-	Carr (Chas.)	1/1½		NIL	12½	—	1/7½	10½d.	2/3	1/-
555,000	1	Clifford (Chas.) Ltd.	29/6		12	10	8 2 6	31/-	26/-	35/-	28/9
45,000	1	Ditto Cum. Pref. 6%	15/-		6	6	8 0 0	15/3	15/-	16/-	15/10½
1,166,000	Stk. (2/-)	Clifford Components V	8/-	+3d.	25*2½C	25*2½C	6 5 0	10/1½	7/3	11/9	6/10½
300,000	2/-	Coley Metals	3/-		15	15	10 0 0	4/5½	3/-	5/-	3/4½
10,185,696	1	Cons. Zinc Corp.†	63/-		20	15	5 17 9	81/6	63/-	80/9	59/6
5,399,056	1	Davy-Ashmore	138/9	—2/9	27½	22½	3 19 0	177/6	129/6	147/3	99/6
8,000,000	5/-	Delta Metal	20/-	—1/3	20	17½	5 0 0	27/7½	19/9	28/3	18/6
5,296,550	Stk. (£1)	Enfield Rolling Mills Ltd.	40/-		15	15	7 10 0	52/3	39/-	56/9	45/-
1,155,000	1	Evered & Co.	43/6		10	10φB	4 12 0	45/9	42/6	42/9	29/3
18,000,000	Stk. (£1)	General Electric Co.	29/-		10	10	6 18 0	39/6	29/-	47/9	29/-
1,500,000	Stk. (10/-)	General Refractories Ltd.	55/-	—1/9	25	20	4 11 0	65/-	42/9	52/6	40/-
937,500	5/-	Glacier Metal Co. Ltd.	18/3	—3d.	15	13	4 2 3	21/1½	13/9	16/1½	11/1½
2,750,000	5/-	Glynwed Tubes	25/-		22½	25¶	4 10 0	30/3	23/-	27/6	17/-
7,228,065	10/-	Goodlass Wall & Lead Industries	33/9	—6d.	15	19L	4 8 9	44/9	32/6	41/9	33/-
696,780	10/-	Greenwood & Batley	18/-	—1/-	15	30‡	8 6 9	29/6	18/-	33/6	29/1½
792,000	5/-	Harrison (B'ham) Ord.	9/3	—3d.	*10	*20‡	5 8 0	14/6	9/3	15/10½	11/9
150,000	1	Ditto Cum. Pref. 7%	19/9		7	7	7 1 9	20/4½	19/7½	23/6	22/-
1,612,750	5/-	Heenan Group	13/-		13	15	5 0 0	17/1½	10/6	13/-	9/10½
251,689,407	Stk. (£1)	Imperial Chemical Industries	67/9	—9d.	13¾	11¼	4 1 3	81/6	63/1½	76/6	54/-
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	14/3	—1½d.	5	5	7 0 3	16/-	13/10½	18/-	15/4½
29,196,118	**	International Nickel	151	—2½	$1.60	$1.50	1 17 0	160	104	105	84¾
6,000,000	1	Johnson, Matthey & Co.	71/6	—1/-	15	12	4 5 0	75/-	57/6	67/6	44/9
600,000	10/-	Keith, Blackman	17/6	+6d.	17½	17½E	10 0 0	21/6	16/6	32/6	17/6
320,000	4/-	London Aluminium	11/10½		13	12	4 7 6	15/-	8/6	12/6	7/10½
1,530,024	1	McKechnie Bros. A Ord.	35/-xcap		12½K	17½F	7 2 9	53/3	35/-	69/3	55/-
1,108,268	5/-	Manganese Bronze & Brass	13/6		20⅝	20⅝	7 14 3	18/6	12/7½	18/6	13/4½
50,628	6/-	Ditto (7½% N.C. Pref.)	5/6		7½	7½	8 3 6	6/-	5/-	6/6	5/9
26,361,444	Stk. (£1)	Metal Box	81/6	—1/6	12	12M	2 18 9	100/9	68/3	84/3	61/-
415,760	Stk. (2/-)	Metal Traders	7/6		50	50	3 6 9	8/9	6/9	10/9	7/1½
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274,170	1/-	Minworth Metals	5/6	—3d.	30	30S	5 9 0	6/3	4/6¾	5/2¼	3/10½
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849,536	5/-	Stedall & Co.	7/6		15	15	10 0 0	10/3	7/6	10/3	6/3
8,035,372	Stk. (£1)	Stone-Platt Industries	53/-	—6d.	16	15	6 0 9	67/-	50/-	64/4½	52/3
2,928,963	Stk. (£1)	Ditto 5½% Cum. Pref.	14/-		5½	5½	7 17 3	18/-	13/6	18/7½	15/3
35,344,881	Stk. (£1)	Tube Investments Ord.	62/-	—1/-	14	20	4 10 0	85/6	62/-	140/3	63/10½
41,000,000	Stk. (£1)	Vickers	32/6	—6d.	10	10	6 3 0	38/3	28/-	39/7½	27/1½
750,000	Stk. (£1)	Ditto Pref. 5%	13/-		5	5	7 13 9	15/-	12/6	17/6	13/3
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	18/6		*5	*5	8 0 3A	21/1½	18/3	24/6	20/1½
4,594,418	1	Ward (Thos. W.) Ord.	72/6		13¾	25	3 15 6	84/6	64/6	94/-	63/-
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323,773	2/-	Wolverhampton Die-Casting	8/9	+3d.	35	30	8 0 0	13/4½	8/3	13/10½	8/1½
591,000	5/-	Wolverhampton Metal	21/3	—9d.	32½	32½	7 13 0	30/-	21/3	39/9	23/9
156,930	2/6	Wright, Bindley & Gell	4/4½		15	20‡	8 11 6	4/9	3/7½	4/6	2/10½
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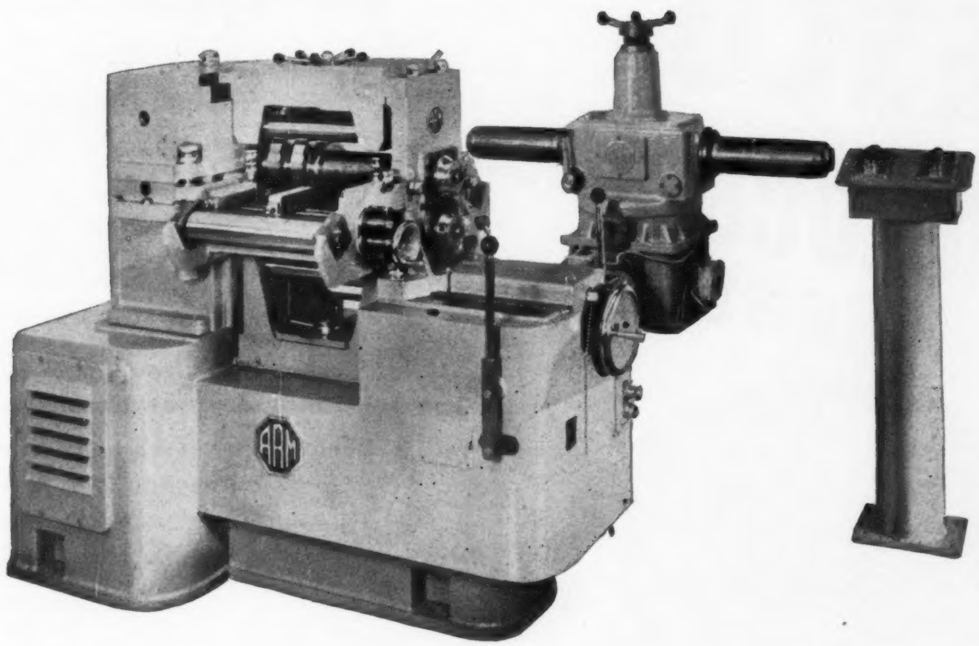

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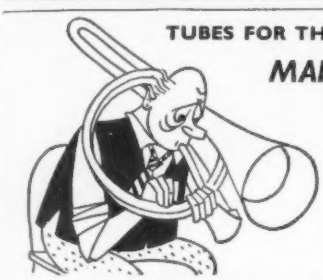

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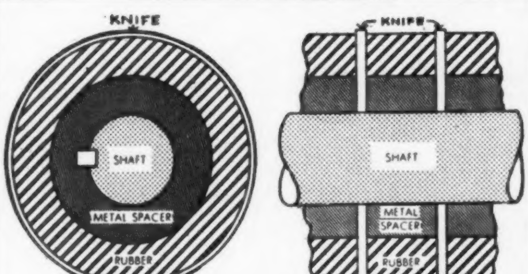

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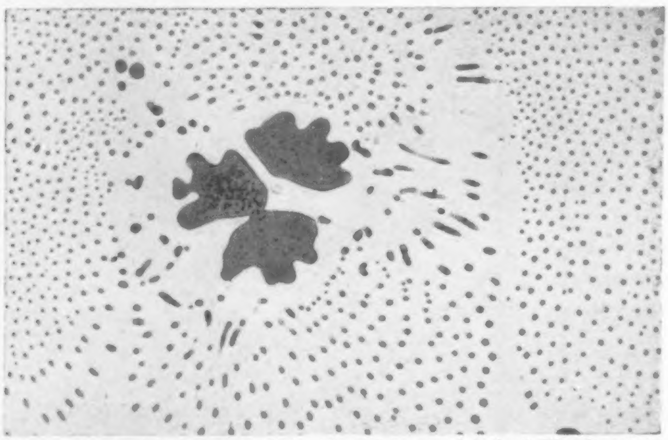

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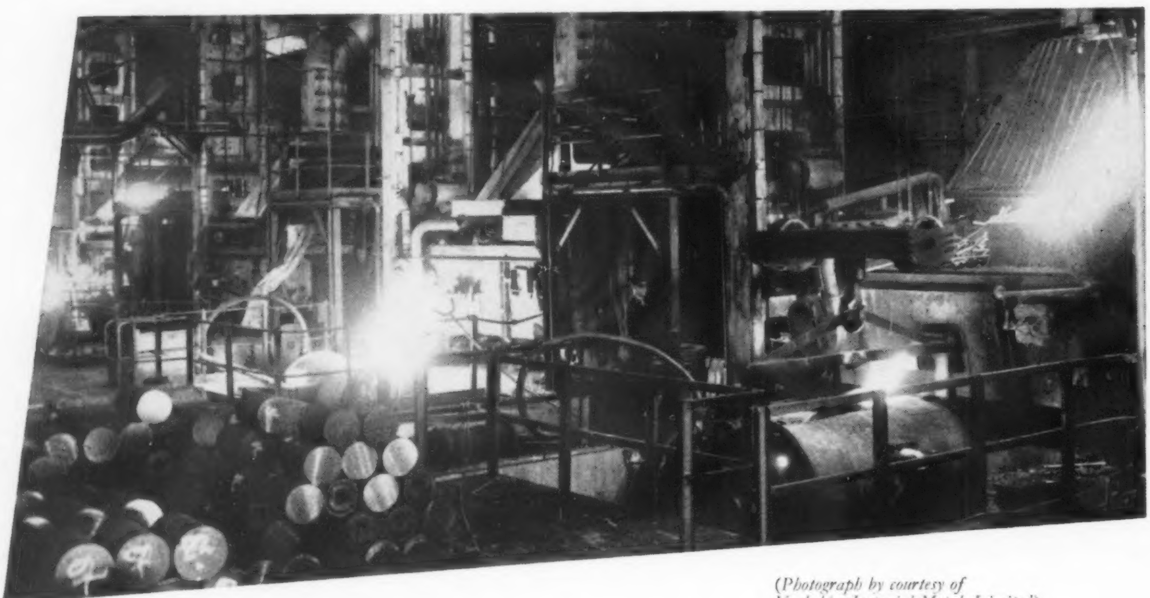

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